IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE HONORABLE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of

Xing LI et al.

Application No.: 10/709,833 Examiner: A. WOLDEMARIAM

Filed: June 1, 2004 Docket No.: 119021

For: SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

BRIEF ON APPEAL

Appeal from Group 2624
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I. REAL PARTY IN INTEREST

The real party in interest for this appeal and the present application is Xerox Corporation, by way of an Assignment recorded in the U.S. Patent and Trademark Office at Reel 014676, Frame 0262.

II. STATEMENT OF RELATED CASES

There are no prior or pending appeals, interferences or judicial proceedings, known to any inventor, any attorney or agent who prepared or prosecuted this application or any other person who was substantively involved in the preparation or prosecution of this application, that may be related to, or that will directly affect or be directly affected by or have a bearing upon, the Board's decision in the pending appeal.

III. JURISDICTIONAL STATEMENT

The Board has jurisdiction under 35 U.S.C. §134(a). The Examiner mailed a Final Rejection on February 10, 2009, setting a three-month shortened statutory period for response. A Notice of Appeal and Pre-Appeal Brief Request for Review were filed on May 1, 2009. The time for filing an Appeal Brief expires the later of two months from the filing of the Notice of Appeal, or one month from the mailing date of the Notice of Panel Decision if a Pre-Appeal Brief Request for Review is sought. Bd.R. 41.37(c) and Official Gazette Notice, July 12, 2005. A Notice of Panel Decision from Pre-Appeal Brief Review was mailed on September 8, 2009, setting a one-month period for filing an Appeal Brief, or the balance of the two-month time period running from the receipt of the Notice of Appeal, whichever is greater. The extendible period for filing the Appeal Brief therefore expires on October 8, 2009. This Appeal Brief is being timely filed on October 8, 2009.

IV. TABLE OF CONTENTS

V. <u>TABLE OF AUTHORITIES</u>

None.

VI. STATUS OF AMENDMENTS

No Amendments After Final Rejection have been filed.

VII. GROUNDS OF REJECTION TO BE REVIEWED

The following grounds of rejection are presented for review:

1) Claims 1-22 are rejected as having been obvious under 35 U.S.C. §103(a) over Lin, U.S. Patent Application Publication No. 2002/0076103 in view of "Appellants' Admitted Prior Art Background section".

VIII. STATEMENT OF FACTS

1. In the rejecting the feature "determining if reclassification is required" of independent claims 1 and 8 under 35 U.S.C. §103(a), the Examiner cites paragraph [0054] and [0059] of Lin. See February 10, 2009 Final Rejection page 4, lines 8-12.

2. Lin discloses a method and apparatus for segmenting an image using a combination of image segmentation techniques. See Abstract.

3. Lin discloses that micro-detection is carried out in step S101 where multiple scanlines of an image are buffered into memory. See paragraph [0053] and Fig. 6.

4. In step S101 a judgment is made as to whether the intensity of the pixel under examination is significantly different than the surrounding pixels. See paragraph [0053] and Fig. 6.

5. In step S103, a macro-detection is performed where the results of the micro-detection step are used to identify those pixels within each scanline that are edges and those pixels that belong to image runs. See paragraph [0054].

6. The image type of each image run is determined based on the micro-detection results. See paragraph [0054] and Fig. 6.

7. In step S105, the image runs of adjacent scanlines are combined to form windows. See paragraph [0055] and Fig. 36.

8. A window is a contiguous area, of an arbitrary shape, having pixels that are all of the same class. See paragraph [0055].

9. In step S107, statistics are gathered and calculated for each of the windows. The statistics are based on the intensity and macro-detection results of each of the pixels within the window. See paragraph [0056].

10. In step S109, the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types and windows containing more than one type of image are classified as mixed. See paragraph [0057].

11. In step S110, the end of the first pass, the beginning point, and the image type of each of the windows is recorded. See paragraph [0058].

12. In step S111, S113 and S115, the micro-detection, macro-detection and window generation steps, respectively, are repeated. See paragraph [0059].

13. In step S117, labeling of the pixels occurs where information about the image type and the window of each pixel is recorded. See paragraph [0059].

14. If a pixel is within a window that was classified as "mixed" during the first pass, the micro-detection, macro-detection and windowing steps

performed during the second pass are used to assign an image type to the pixel. See paragraph [0059].

15. At the end of the labeling step, each pixel is labeled as a particular image type. See paragraph [0059].

16. Lin teaches not to record the macro-detection and micro-detection results for each pixel. See paragraph [0060].

17. Lin indicates that the reason for not recording the micro-detection and macro-detection results from the first pass for each pixel of the image is because it minimizes the cost of the apparatus. See paragraph [0060].

18. The Examiner asserts that Lin discloses determining if reclassification is required in paragraphs [0054] and [0059]. See February 10, 2009 Final Rejection, page 4, lines 8-12.

19. Appellants disagree with Fact 18.

20. The Examiner acknowledges that Lin does not disclose the background intensity level being based on substantially all of the pixels of the image. See February 10, 2009 Final Rejection, page 4, lines 13-17.

21. The Examiner asserts that "Appellants' admitted prior art" discloses that conventionally background detection is performed by sampling pixel values either within a sub-region of the document or across the whole document (i.e., being based on substantially all of the pixel values

(intensity level)) of the image, and cites paragraph [0012] as support. See Final Rejection, page 4, lines 14-17.

22. Appellants disagree with Fact 21.

23. American Heritage College Dictionary, fourth edition defines "sampling" as "a small portion, pieces, or segment". See page 1228.

24. The Examiner further asserts that it would have been obvious to [one of] ordinary skill in the art at the time when the invention was made to use Appellants' admitted prior art teachings to modify Lin's method by detecting the background based on substantially all of the pixels' intensity level of the image in order to more accurately reproduce the image, and cites Appellants' specification paragraph [0009], lines 6-10. See February 10, 2009 Final Rejection, page 4, lines 13-17.

25. Appellants disagree with Fact 24.

26. Appellants disclose that it may be advantageous to classify pixels of different image types differently, and that the misclassification of a pixel as background can affect background suppression. See Appellants' specification at paragraph [0013].

27. Appellants' Background of the Invention section discloses that to improve quality of reproduced images, it is determined what type of image is being represented by the captured image data, and that the

image data is generally stored as multiple scan lines, where each scan line comprises multiple pixels. See paragraph [0004].

28. Appellants' Background section acknowledges that it is known to determine an image type by separating pixels representing different types of images and separating the image data into windows of similar image types. See Appellants' specification at paragraph [0005].

29. Appellants' Background section acknowledges two known methods of classification of each pixel, the one pass method and the two pass method. See Appellants' specification at paragraph [0008].

30. Appellants acknowledge that in known two pass methods, each pixel is labeled in view of the information obtained after all pixels have been analyzed by the first pass. See Appellants' specification at paragraph [0008].

31. Appellants' specification notes that in the first pass analyzing step, only a few scan lines of the image are analyzed. See Appellants' specification at paragraph [0008].

32. Appellants' specification indicates that the information obtained from the first pass for scan lines processed after the processing of a scan line during the first pass, is used to classify the pixels before the second pass during which the image data is processed, based on the determined classification. See Appellants' specification at paragraph [0008].

33. Appellants' specification acknowledges that it is known to perform background detection by sampling pixel values either within a sub-region of the document (typically leading edge) or across the whole document, and that for conventional processes, only a portion (i.e., not the full document) is used to detect the background of the document to be reproduced. See Appellants' specification at paragraph [0012].

34. Appellants discovered that image quality is enhanced when pixels are classified based on substantially all of the pixels of the image. See Appellants' specification at paragraph [0012].

35. In rejecting independent claims 1 and 8, the Final Rejection relies on Appellants' specification at paragraph [0012] as disclosing that background detection is performed based on substantially all of the pixels. Final Rejection at page 4, lines 13-17.

36. Appellants disagree with Fact 35.

37. In rejecting independent claim 15, the Examiner relies on similar or identical reasoning as the rejection of claims 1 and 8. Final Rejection, page 2, lines 20-21.

38. Appellants disagree with Fact 37.

39. Prior to this Appeal, Appellants appealed the Examiner's rejection alleging that Fan (U.S. Patent No. 5,850,474) discloses the background detection is "based on substantially all of the pixels".

40. An Appeal Brief was filed on July 8, 2008.

41. In view of the July 8, 2008 Appeal Brief, prosecution was re-opened, and the September 4, 2008 Office Action was issued.

42. The September 4, 2008 Office Action contains the currently Appealed rejection. See September 4, 2008 rejection, page 2-5.

IX. ARGUMENT

The Examiner asserts that Appellants' "admitted prior art background section" discloses the feature "determining a background intensity level of an image, the background intensity level being based on substantially all of the pixels of the image" as recited in independent claims 1 and 8, thereby allegedly rendering such claims obvious. February 10, 2009 Final Office Action (hereinafter "Final Rejection"), page 2, lines 7-21; April 14, 2009 Advisory Action, page 2. In response, Appellants previously pointed out how the Examiner has erred. November 5, 2008 Interview; November 12, 2008 Amendment, pages 6-8; March 10, 2009 Request for Reconsideration After Final Rejection, pages 2-3; and May 1, 2009 Pre-Appeal Brief Request for Review, pages 1-4.

The Examiner rejects "determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image" recited in independent claim 15 for reasons similar to those explained above regard to claims 1 and 8.

The Examiner further asserts that Lin discloses the feature "determining if reclassification is required" as recited in independent claims 1 and 8, thereby allegedly rendering such claims obvious. (September 4, 2008 Rejection, page 4, line 12-16, February 10, 2009 Final Rejection, page 4, lines 8-12). In response, Appellants previously pointed out how the Examiner has erred.

(November 12, 2008 Amendment, page 7; March 10, 2009 Request for Reconsideration After Final Rejection, page 3; May 1, 2009 Pre-Appeal Brief Request for Review, pages 3 and 4).

The Examiner rejects "reclassifying pixels based on the results of the checking step" recited in claim 15 for reasons similar to those explained above regarding claims 1 and 8. Appellants explain again below why the Examiner's rejections of claims 1-22 for alleged obviousness over Lin in view of "Appellants' Admitted Prior Art", is erroneous.

A. Lin In View Of "Appellants' Admitted Prior Art" Fails To Disclose or Render Obvious "The Background Intensity Level Being Based On Substantially All Of The Pixels Of The Image" Recited In Independent Claim 1 And Similarly Recited in Independent Claim 8 And "The Background Level Being Based On Substantially All Of The Pixels Of The Image," As Recited In Independent Claim 15

Independent claims 1 and 8 recite, *inter alia*, "determining/determines a background intensity level of an image...based on substantially all of the pixels of the image".

Appellants discovered that it may be advantageous to classify pixels of different image types differently, and that the misclassification of a pixel as background, for example, can affect background suppression and also the rendering of the types of pixels of an image. (Fact 26). In summary, Appellants discovered that by using only a first pass edge or other sub-region information and not reclassifying pixels classified as background during the

first pass leads to misclassification of pixels. (Fact 26). Appellants discovered that pixel classification is improved when the pixels are classified based on substantially all of the pixels of the image and then the classification of each pixel is confirmed. (Fact 34).

Appellants' Description of Related Art section discloses that "background detection is performed by sampling pixel values either within a sub-region of the document (typically, leading end) or across the whole documents" (emphasis added). In particular, paragraph [0012] states:

> Conventionally, background detection is performed by sampling pixel values either within a sub-region of the document (typically, the leading edge) or across the whole document. For conventional processes, only a portion (i.e., not the full document) is used to detect the background of the document to be reproduced. The detected lead-edge or other sub-region background information is then used to process and classify each of the pixels of the scanned image.

The use of "sampling" in Appellants' specification is consistent with its commonly understood meaning to refer to "a small portion, pieces, or segment." (Fact 23). This conventional method of determining intensity level of an image based on sampling pixel values is not..."a pixel classification...based on

substantially all the pixels of the image..." as recited in independent claims 1 and 8. "Sampling" is the antithesis of "substantially all." Appellants' specification is consistent with this ordinary meaning of "sampling" in that Appellants' specification explicitly indicates that determining "based on substantially all the pixels..." is different from "sampling". See, for example, paragraphs [0014] and [0056] of Appellants' specification (especially last sentence of paragraph [0056]), which are reproduced below.

> Various exemplary embodiments of the invention provide a pixel classification method for classifying pixels of an image by determining a background intensity level of an image which is based on substantially all of the pixels of the image. The method also involves checking the classification of the pixel based on the determined background intensity level of the image.
>
> Various exemplary embodiments of the invention may be incorporated into the exemplary segmentation and processing method described above. In particular, various exemplary embodiments of the invention use the results of a full page based background detection to adjust, as necessary, the classification of the pixels by checking the classification. Various exemplary embodiments of the invention check the classification of a pixel by comparing the intensity of the pixel with the intensity of the

white point or the background intensity level of the image. The white point or the background intensity level of the image is determined based on an analysis of substantially all of the pixels of the document, and not just a sampling of the pixels or a sub-region of the image.

Regarding independent claim 15, "admitted prior art" fails to disclose or render obvious "determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image". Lin classifies the intensity level of each pixel based on the intensity of its surrounding pixels, <u>not</u> based on a background intensity level that is based on substantially all of the pixels of the image. (Facts 4-16). As explained above, the "admitted prior art" also does not disclose this feature.

Thus, one having ordinary skill in the art would not have modified Lin in view of Appellants' "admitted prior art" to obtain the combination of features recited in independent claims 1, 8 and 15.

Accordingly, Lin in view of Appellants' "admitted prior art" is clearly missing "the background level being based on substantially all of the pixels of the image".

B. Lin In View Of Appellants' Admitted Prior Art Fails To Disclose Or Render Obvious "Determining If Reclassification Is Required" As Recited In Independent Claims 1 And 8 And "Reclassifying Pixels Based On Result Of The Checking Step" As Recited In Independent Claim 15

The Final Rejection asserts that Lin discloses "determining if reclassification is required;" and "reclassifying the pixel when reclassification is required." (Fact 1). Appellants respectfully disagree.

Lin discloses a method and apparatus for segmenting using a combination of image segmentation techniques. (Fact 2). Lin discloses that during a first step S101, a micro-detection is carried out where multiple scan lines of an image are buffered into memory. (Fact 3). That is, only a few scan lines of the image are analyzed. (Fact 3). During a second step S103, a micro-detection is performed where the results of the micro-detection step are used to identify those pixels within each scan line that are edges in those pixels that belong to image runs. (Fact 5). The image type of each image run is then determined based on the micro-detection results. (Fact 6). In the next step S105, the image runs of adjacent scan lines are combined to form windows. (Fact 7). A window is a contiguous area in an image, of an arbitrary shape, where all pixels are of the same class. (Fact 8). In step S107, statistics are gathered and calculated for each of the windows. (Fact 9). In step S109, the statistics are examined in an attempt to classify each window. (Fact 10). However, the micro-detection and macro-detection results from the first pass

are not recorded for each pixel of the image, to minimize the memory requirements of a device embodying the invention, which renders determining if reclassification is required impossible. (Facts 16 and 17).

Lin teaches away from the claims 1 and 8 feature of "determining if reclassification is required..." since at the time Lin makes a first pass of the image, Lin does not record the macro-detection or micro-detection results for each pixel of the image. (Fact 17). More specifically, because Lin does not record the macro-detection or micro-detection results for each pixel, it is impossible for each pixel to be reclassified, as recited in independent claims 1 and 8.

Additionally, the February 2, 2009 Final Rejection and April 14, 2009 Advisory Action do not respond to Appellants' argument that Lin teaches away from the claims 1 and 8 feature of "determining if reclassification is required..." because at the time Lin makes a first pass of the image, Lin does not record the macro-detection or micro-detection results from the pixel of the image. Lin paragraph [0060] states:

> Once each portion of the image data has been classified according to standard image types, further processing of the image data can be efficiently performed. Because the micro-detection and macro-detection results from the first pass are not recorded for each pixel

of the image, the memory requirements for a device embodying the invention are minimized. This helps to minimize the cost of such an apparatus.

Appellants' specification explicitly acknowledges systems such as Lin's and distinguishes from such systems, for example, at paragraph [0013], which states:

> In known two-pass methods, for example, the original classification of a pixel as background is done during the first pass using lead-edge or other sub-region information and pixels misclassified as background during the first pass are not re-classified during the second pass. As lead-edge or other sub-region information may not be a true indication of the background of the captured image, misclassification of pixels as background can occur. For example, a background pixel can be classified as smooth contone or vise versa. Similarly, in known two-pass methods, pixels are subjected to a second pass when the pixel was associated with a "mixed" window during the first pass. Thus, in known classification methods, the classification of a pixel is not reconsidered. However, as discussed above, because it may be advantageous to classify pixels of different

image types differently, the misclassification of a pixel as background, for example, can affect background suppression and also the rendering of the types of pixels.

Lin performs the pixel classification as explained in Appellants' Background of the Invention section. (Facts 13-17). Thus, because Lin does not record the macro-detection or micro-detection results of each pixel, it is impossible for each pixel to be reclassified, as recited in independent claims 1 and 8.

Regarding independent claim 15, Lin fails to disclose or render obvious "checking the classification of at least portion of the pixels of the image based on the determined background intensity level image ...." Lin classifies the intensity of each pixel based on the intensity of its surrounding pixels, <u>not</u> based on a background intensity level that is based on substantially all of the pixels of the image. See Lin, paragraph [0053]. As explained above, the "admitted prior art" does not disclose this feature.

C. <u>Dependent Claims</u>

Claims 2-7, 9-14 and 16-22 depend either directly or indirectly from one of independent claims 1, 8 and 15. Claims 2-7, 9-14 and 16-22 are thus patentable at least for their dependency from their respective independent claims, as well as for the additional features they recite.

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For all of the reasons discussed above, it is respectfully submitted that the rejections are in error and that claims 1-22 are in condition for allowance. For all of the above reasons, Appellants respectfully request this Honorable Board to reverse the rejection of claims 1-22.

Respectfully submitted,

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X. APPENDIX A - CLAIMS SECTION

1. (Rejected) A pixel classification method, comprising:

determining a background intensity level of an image, the background intensity level being based on substantially all of the pixels of the image;

classifying a pixel of the image;

confirming the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level;

determining if reclassification is required; and

reclassifying the pixel when reclassification is required.

2. (Rejected) The pixel classification method of claim 1, wherein the determining step comprises determining a white point of the image based on at least one characteristic of substantially all of the pixels of the image.

3. (Rejected) The pixel classification method of claim 2, wherein the confirming step comprises comparing the intensity of the pixel with an intensity of the white point of the image.

4. (Rejected) The pixel classification method of claim 3, wherein the reclassifying step includes reclassifying the pixel as background when the pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image.

5. (Rejected) The pixel classification method of claim 3, wherein the reclassifying step includes reclassifying the pixel as one of smooth contone and an equivalent class when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image.

6. (Rejected) The pixel classification method of claim 1, wherein the determining step comprises identifying a spread of intensity levels of substantially all the pixels of the image and determining an intensity level of a majority of the pixels.

7. (Rejected) The pixel classification method of claim 4, wherein the pixel is classified as smooth contone.

8. (Rejected) A pixel classification apparatus, comprising:

a background intensity level determining module that determines a background intensity level of an image based on substantially all of the pixels of the image; and

an image processing module that classifies a pixel of the image, confirms the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level, determines if reclassification is required, and reclassifies the pixel when reclassification is required.

9. (Rejected) The pixel classification apparatus of claim 8, wherein the background intensity level determining module determines a white point of

the image based on a characteristic of substantially all of the pixels of the image.

10. (Rejected) The pixel classification apparatus of claim 9, wherein the image processing module confirms the classification of the pixel by comparing the intensity of the pixel with the intensity of the white point of the image.

11. (Rejected) The pixel classification apparatus of claim 10, wherein when a pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

12. (Rejected) The pixel classification apparatus of claim 10, wherein when a pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

13. (Rejected) The pixel classification apparatus of claim 8, wherein the image processing module identifies a spread of intensity levels of substantially all the pixels of the image and determines an intensity level of a majority of the pixels.

14. (Rejected) The pixel classification apparatus of claim 11, wherein the pixel is classified as one of smooth contone and an equivalent class.

15. (Rejected) An image processing method, comprising:

determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image;

classifying a pixel of the image;

checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image;

reclassifying pixels based on results of the checking step; and

processing image data of the pixels of the image based on the classification of the pixels.

16. (Rejected) The image processing method of claim 15, further comprising storing a label associated with each of substantially all of the pixels, wherein the label of each of substantially all of the pixels is based on results of the classification step and the checking step for the pixel.

17. (Rejected) The image processing method of claim 15, wherein classifying a pixel of the image comprises classifying the pixel as one of smooth contone, rough contone, text, background, graphics and halftone.

18. (Rejected) The image processing method of claim 15, wherein the determining step comprises determining a white point of the image based on a characteristic of substantially all of the pixels of the image.

19. (Rejected) The image processing method of claim 18, wherein the checking step comprises comparing an intensity of the pixel with an intensity of the white point of the image.

20. (Rejected) The image processing method of claim 19, wherein when the pixel is classified as smooth contone and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

21. (Rejected) The image processing method of claim 19, wherein when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

22. (Rejected) The image processing method of claim 15, wherein the portion of the pixels comprises substantially all of the pixels of the image.

XI. APPENDIX B - CLAIM SUPPORT AND DRAWING ANALYSIS SECTION

1. A pixel classification method, {**paragraphs [0001]; [0013]; and [0027]**} comprising:

determining a background intensity level of an image, {**[0014]; [0054]-[0056]; [0058]; Figure 9, S910**} the background intensity level being based on substantially all of the pixels of the image {**[0014]-[0016]; [0056]; [0058]; Figure 9, S910**};

classifying a pixel of the image {**]0015]; [0016], [0027]; [0028]; [0036]; [0040]; [0041]-[0044]; [0046]; [0052]; and [0058]; and Figure 9, S910**};

confirming the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level {**[0014]-[0016]; [0028]; [0058]; [0062]; [0063]; and Figure 9, S930**};

determining if reclassification is required {**[0054]; [0058]; [0062]; [0063]; and Figure 9, S940**}; and

reclassifying the pixel when reclassification is required {**[0016]; [0027]; [0054]; [0059]-[0062]; and Figure 9, S940**}.

8. A pixel classification apparatus, comprising:

a background intensity level determining module {**[0015]; [0027]; Figure 2 elements 70; 110 and Figure 3**} that determines a background

intensity level of an image based on substantially all of the pixels of the image {**[0014]-[0016]; [0056]; [0058], and Figure 9, S910**}; and

an image processing module {**[0015]; [0027]; [0033]; [0064]; and Figure 2 elements 70, 110 and Figure 3**} that classifies a pixel of the image {**[0015]-[0016]; [0027]-[0028]; [0036]; [0040]-[0042]; [0044]; [0046]; [0052]; [0058]; and Figure 9, S920**}, confirms the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level {**[0014]-[0016]; [0028]; [0058]; [0062]-[0063]; and Figure 9, S930**}, determines if reclassification is required {**[0054]; [0058]; [0062]-[0063]; and Figure 9, S940**}, and reclassifies the pixel when reclassification is required {**[0016]; [0027]; [0054]; [0059]-[0062]; and Figure 9, S940**}.

15. An image processing method {**[0001]; [0013]; and [0027]**}, comprising:

determining a background intensity level of an image {**[0014]; [0054]-[0056]; [0058]; and Figure 9, S910**}, the background level being based on substantially all of the pixels of the image {**[0014]-[0016]; [0056]; [0058]; and Figure 9, S910**};

classifying a pixel of the image {**[0015]-[0016]; [0027]-[0028]; [0036]; [0040]-[0042]; [0044]; [0046]; [0052]; [0058]; and Figure 9, S920**};

checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image {**[0014]-[0016]; [0028]; [0058]; [0062]-[0063]]; and Figure 9, S930**};

reclassifying pixels based on results of the checking step {**[0016]; [0027]; [0054]; [0059]-[0062]; and Figure 9, S940**}; and

processing image data of the pixels of the image based on the classification of the pixels {**[0016]; [0040]; [0053]; [0064]**}.

XII. APPENDIX C - MEANS OR STEP PLUS FUNCTION ANALYSIS SECTION

NONE

XIII. APPENDIX D - EVIDENCE SECTION

A copy of each of the following items of evidence relied on by the Appellant and/or the Examiner in this appeal is attached:

Table of Contents

Electronic Version

Stylesheet Version v1.1.1

Description

SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

BACKGROUND OF THE INVENTION

1. FIELD OF INVENTION

[0001] The present invention relates generally to pixel classification of a scanned image and, more particularly, to using background detection results for adjusting and/or determining the classification of a pixel.

2. DESCRIPTION OF RELATED ART

[0002] Image capture devices, such as scanners, and image forming devices, such as copiers, convert the light reflected from an original document into electrical charges that represent the light intensity of predetermined areas, e.g., pixels, of the document. The electrical charges are then processed and signals that can be used to recreate the captured image are generated.

[0003] One criteria for evaluating the performance of an image capture device or an image forming device is how well the reproduced image matches the original image. To improve the quality of the reproduced image, multiple steps and considerations are involved during the processing of the captured image data.

[0004] For example, to improve the quality of the reproduced image, generally, it is determined what type of image is being represented by the captured image data. Image data is generally stored in the form of multiple scan lines, where each scan line comprises multiple pixels. When processing the image data, it is advantageous to know the type of image represented by the data because it may be advantageous to process each of the image types differently. The image data can represent various types of images including, for example, graphics, text, background, smooth continuous tone (smooth contone), rough continuous tone (rough contone), and halftones of different frequencies. Further, a page of image data can be a single image type or some combination of image types.

[0005]

To determine the type of image being represented by a pixel and to separate pixels representing different types of images, it is known, for example, to take a page of image data and to separate the image data into windows of similar image types. A page of image data may, for example, include a halftoned picture with accompanying text describing the picture. To efficiently process the image data, the page of the image data may be separated into windows such that a first window represents the halftoned image and the second window represents the text. Processing of the image data is then carried out by customizing the processing based on the type of image data being processed in order to improve the quality of the reproduced image. For example, the image data may be subjected to different filtering

mechanisms based on the determined type of the image data.

[0006] Accordingly, in order to improve the quality of the reproduced image, it is important for image data to be classified correctly. If the image data is not classified correctly, inappropriate processing may actually diminish the quality of the image data and the reproduced image.

[0007] When classifying each pixel individually or when grouping the image data such that each group of pixels (e.g., a window) represents a different type of image data, generally, it is known to make either one or two passes through the page of image data.

[0008] In the one pass method, the classification of the pixel is based on the information obtained regarding the pixel during a single pass through the image data, and thus, processing is performed "on the fly" such that pixels are classified after only one or a few scan lines are analyzed. On the other hand, in the two pass method, each pixel is processed and labeled in view of the information obtained after all the pixels have been analyzed. More particularly, in the two pass method, information obtained from the first pass for scan lines processed after the processing of a scan line during the first pass is used to classify the pixels before the second pass during which the image data is processed, based on the determined classifications. For example, in the two pass method, information obtained for a subsequent scan line can be used to generate or correct information for a previous scan line. In some two pass methods, two rounds of pixel level analysis are performed on all the pixels before the pixels are classified while in

other two pass methods a single round of pixel level analysis (i.e., a single run through the pixels of the image) is performed before the pixels are classified. U.S. Patent No. 5,850,474, the entire disclosure of which is incorporated herein by reference, discloses an example of such a two-pass method.

[0009] Another example of a step which may be carried out to improve the quality of the reproduced image is determining the contrast of the original image. The contrast of the original image is determined before the captured image data is processed and the determined contrast is used to process the image data. Background detection processes are helpful for determining the contrast of an image. By determining the background of the original document, the background of the captured image can be used to more accurately reproduce the image.

[0010] Generally, background detection processes collect light intensity information and use the collected light intensity information to determine an intensity level associated with the document background. The determined intensity level is also referred to as the "background intensity level". Using the image data of the captured image, statistical analysis, generally a histogram, can reveal a peak which identifies the intensity of a majority of the pixels. The peak may be referred to as a white-peak, a white point or a background peak. The white peak, for example, is the gray level with the greatest number of pixels having an intensity related to the white background of the scanned image.

[0011] The histogram is also used to determine the gain factor for the document. The gain factor is used to compensate for the background gray level of the image of the scanned document. It should be noted, however, that although the histogram assists in the determination of the background value for the document (page), the background value is only as accurate as the created histogram and the identified peak of the histogram on which it is based.

[0012] Conventionally, background detection is performed by sampling pixel values either within a sub-region of the document (typically, the leading edge) or across the whole document. For conventional processes, only a portion (i.e., not the full document) is used to detect the background of the document to be reproduced. The detected lead-edge or other sub-region background information is then used to process and classify each of the pixels of the scanned image.

SUMMARY OF THE INVENTION

[0013] In known two-pass methods, for example, the original classification of a pixel as background is done during the first pass using lead-edge or other sub-region information and pixels classified as background during the first pass are not re-classified during the second pass. As lead-edge or other sub-region information may not be a true indication of the background of the captured image, misclassification of pixels as background can occur. For example, a background pixel can be classified as smooth contone or vise versa. Similarly, in known two-pass methods, pixels are subjected to a second pass when the pixel

was associated with a "mixed" window during the first pass. Thus, in known classification methods, the classification of a pixel is not reconsidered. However, as discussed above, because it may be advantageous to classify pixels of different image types differently, the misclassification of a pixel as background, for example, can affect background suppression and also the rendering of the types of pixels.

[0014] Various exemplary embodiments of the invention provide a pixel classification method for classifying pixels of an image by determining a background intensity level of an image which is based on substantially all of the pixels of the image. The method also involves checking the classification of the pixel based on the determined background intensity level of the image.

[0015] Various exemplary embodiments of the invention separately provide a pixel classification apparatus. The pixel classification apparatus includes a background intensity level determining module which determines a background intensity level of an image based on substantially all of the pixels of the image. The pixel classification apparatus also includes an image processing module which classifies a pixel of the image, and checks the classification of the pixel based on the determined background intensity level of the image.

[0016] Various exemplary embodiments of the invention separately provide an image processing method. The image processing method determines a background level of an image, based on substantially all of the pixels of the image. The image processing method also

classifies a pixel of the image, checks the classification of the pixel based on the determined background intensity level of the image, reclassifies pixels based on the results of the checking step and processes image data based on the classification of the pixel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Various exemplary embodiments of systems and methods of the invention will be described in detail, with reference to the following figures.

[0018] Fig. 1 is a diagram illustrating components of an exemplary digital scanner.

[0019] Fig. 2 is a block diagram illustrating the electronic architecture of an exemplary digital scanner coupled to a workstation, a network, a storage medium and an image output terminal in accordance with various exemplary embodiments of the invention.

[0020] Fig. 3 is a block diagram illustrating an exemplary architecture of an image processing module.

[0021] Fig. 4 shows an exemplary two-dimensional look-up table which may be used to classify image data.

[0022] Fig. 5 is a block diagram of another exemplary embodiment of an image segmentation module.

[0023] Fig. 6 is a flowchart outlining an exemplary two pass segmentation and classification method.

[0024] Fig. 7 shows a graphical representation of a scan line of image data.

[0025] Fig. 8 shows a graphical representation of scan lines of image data that have been separated into windows.

[0026] Fig. 9 is a flowchart outlining an exemplary method for classifying pixels of an image.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0027] The invention generally relates to methods and systems for adjusting, as necessary, and/or determining the classification of the pixels of a document based on full-page background detection results during capture and out of an image, for example, by a digital scanner. Such a digital scanner is capable of being connected to a wide array of copiers, printers, computers, networks, facsimile machines, and the like, and is capable of scanning and producing complex and interesting images to be stored, printed and/or displayed. The images may include text, graphics, and/or scanned or computer-generated images. With such a scanner, high quality image output can be achieved by automatically determining an image background based on the results of a full-page background detection process and using the image background to dynamically adjust/reclassify, as necessary, or more accurately determine, the classification of a pixel.

[0028]

It should be understood that various exemplary embodiments of the invention may be used in conjunction with any known pixel classification method in order to adjust, confirm and/or determine the

classification of a pixel by using the results of a full-page background detection process for the document. However, for purposes of illustration, exemplary embodiments of classification and/or segmentation processes are described below. Various exemplary embodiments of the invention may be used to adjust and/or confirm the classification of pixels obtained using, for example, the methods described below.

[0029] Fig. 1 illustrates components of an exemplary scanning unit 20 of a digital scanner. In the scanning unit 20, a light source 21 is used to illuminate a document 22 to be scanned. In a platen-type scanning situation, the document 22 usually rests upon a glass platen 24, which supports the document 22 for scanning purposes. The document 22 may be placed on the glass platen 24 by an operator. Alternatively, the scanning unit may include a feeder or document handler 29, which places the document on the glass 24.

[0030] On top of the glass platen 24 and the document 22, a backdrop portion (platen cover) 26 is placed to prevent stray light from leaving the scanning area to provide a background from which an input document can be distinguished. The backdrop portion 26 may be part of document handler 29. The backdrop portion 26 is the surface or surfaces that can be scanned by an image-sensing unit 28 when a document is or is not present in the scanning station. The light reflected from the document passes through a lens subsystem (not shown) so that the reflected light impinges upon the image sensing

unit 28, such as a charge coupled device (CCD) array or a full width array.

[0031] A full width array typically comprises one or more linear arrays of photo-sites, wherein each linear array may be sensitive to one or more colors. In a color image capture device, the linear arrays of photo-sites are used to produce electrical signals which are converted to color image data representing the scanned document. However, in a black-and-white scanner, preferably, only one linear array of photo-sites is used to produce the electrical signals that are converted to black and white image data representing the image of the scanned document.

[0032] Fig. 2 is a block diagram illustrating the electronic architecture of an exemplary digital scanner 30 including the scanning unit 20. The digital scanner 30 is coupled to a workstation 50 by way of a scanning interface 40. An example of a suitable scanning interface is a SCSI interface. Examples of the workstation 50 include a personal computer or a computer terminal. The workstation 50 includes and/or has access to a storage medium 52. The workstation 50 may be adapted to communicate with a computer network 54, and/or to communicate with the Internet either directly or through the computer network 54. The digital scanner 30 may be coupled to at least one image output terminal (IOT) 60, such as a printing system, via the workstation 50, for example.

[0033] The scanning unit 20 scans an image and converts the analog signals

received by the image sensing unit 28 into digital signals (digital data). An image processing unit 70 registers each image, and may execute signal correction to enhance the digital signals. As the image processing unit 70 continuously processes the data, a first-in first-out (FIFO) buffer 75 temporarily stores the digital data output by the image processing unit 70, and transmits the digital data, for example, to the International Telecommunications Union (ITU) G3/G4 80 and Joint Photographic Experts Group (JPEG) 85 in bursts, so that the processed data is compressed. Other data compression units may be substituted for the ITU G3/G4 80 and the JPEG 85. The compressed digital data is stored in a memory 100, for example, by way of a Peripheral Component Interconnect Direct Memory Access (PCI/DMA) Controller 90 and a video bus 95. Alternatively, an operator may not wish to compress the digital data. The operator may bypass the compression step so that the data processed by the image processing unit 70 is sent through FIFO 75 and directly stored in the memory 100 by way of the PCI DMA controller 90.

[0034]

A computing unit 110, such as a microprocessor, is coupled to the scanner interface 40, the memory 100 and the PCI DMA controller 90 by way of the video bus 95 and a video bus bridge 120. The computing unit 110 is also coupled to a flash memory 130, a static RAM 140 and a display 150. The computing unit 110 communicates with the scanning unit 20 and the image processing unit 70, for example, by way of a control/data bus. For example, the computing

unit 110 may communicate with the image processing unit 70 through the video bus 95 and/or the PCI DMA controller 90. Alternatively, the computing unit 110 may communicate directly with different components, such as the image processing unit 70 by way of control/data buses (not shown).

[0035] Fig. 3 shows an exemplary architecture of an image segmentation apparatus 300 which may form part of the image processing unit 70 shown in Fig. 2.

[0036] Fig. 3 shows two exemplary features that may be extracted and used for image processing and/or segmentation in order to improve the quality of the reproduced image. The two features are video peak/valley count within a window containing the pixel being classified and local roughness.

[0037] Local roughness may represent the degree of gray level discontinuity computed as a combination of some gradient operators. One example of local roughness is the difference between the maximum and minimum of nine 3 x 3 window sums within a 5 x 5 video context. It should be understood that various exemplary embodiments of the invention may be used in conjunction with any known or hereafter developed methods of determining the local roughness.

[0038]

On the other hand, a pixel may be considered as a video peak or video valley, respectively, if its gray level is the highest or the lowest in a neighborhood and the gray level difference between the gray level

of the pixel and the gray level of the neighborhood average is greater than a certain threshold. It should be understood that various exemplary embodiments of the invention may be used in conjunction with any known or hereafter developed methods for determining video peaks and/or video valleys.

[0039] Several lines of peak and valley patterns may be recorded in scan line buffers for computing peak/valley count within a defined window. For example, various exemplary embodiments of the invention may be used in a system where the peak/valley count and local roughness are used as indices to form a two-dimensional look-up table (hereafter also called a classification table) as a basis to classify image data.

[0040] FIG. 4 shows an example of a two-dimensional look up table that uses five roughness levels and twelve peak/valley count levels. As a result, the look up table includes sixty classification table entries (i.e., 5x12=60). Depending on a location within the look-up table, the video data may be mapped to certain classifications such as low frequency halftone, high frequency halftone, smooth continuous tone, rough continuous tone, edge, text on halftone, and the like. Depending on the classification, the input data may be processed differently. For example, different filters may be applied, based on the classification, during processing of the data in order to improve the overall quality of the reproduced image.

[0041] Various exemplary embodiments of the invention may be used in conjunction with a system in which the look-up table (i.e., classification

table) is complemented with some special classifications. One example of a possible special classification is the "edge classification". The "edge classification" tries to identify some line art and kanji area that could be missed by the look-up table. Another example of a special classification is the "white classification ". The "white classification " makes use of the absolute gray level information in addition to peak/valley count and roughness. A "default classification " may be used for the borders of an image. The classification look-up table output may be multiplexed with the special classification to produce the final classification of a pixel (i.e., classification output). The classification table assignment may be programmable to allow for more flexibility in rendering adjustment.

[0042]

Fig. 5 shows a block diagram of a page segmentation and classification apparatus 500 as another example of a portion of the image processing unit 70 shown in Fig. 2. The page segmentation and classification apparatus 500 performs a two-pass segmentation and classification method. The page segmentation and classification apparatus 500 includes micro-detection means 520 for performing a micro-detection step, macro-detection means 530 for performing a macro-detection step and windowing means 540 for grouping image runs of the scan lines together to form windows. The apparatus 500 also includes statistics means 550 for gathering and calculating statistics regarding the pixels within each window and classification means 560 for classifying each of the windows as a particular image

type based on the gathered statistics.

[0043] Memory means 570 is provided for recording the beginning points and image types of each of the windows and the beginning points and image types of any initially unknown image runs that are subsequently classified during the first pass. The memory means 570 may also be used to store the window and image type of each pixel at the end of the second pass. Typically, however, the image data is used immediately to process, transmit and/or print the image, and the image data is then discarded.

[0044] Fig. 6 shows a block diagram illustrating an exemplary two pass segmentation and classification method which may be performed using the apparatus 500 shown in Fig. 5. The two pass segmentation and classification method may be used in conjunction with various exemplary embodiments of the invention. The method segments a page of image data into windows, classifies the image data within each window as a particular image type and records information regarding the window and image type of each pixel. Once the image type for each window and/or pixel is known, further processing of the image data can be efficiently performed during the second pass. For example, during the second pass, when the image data is being processed, different filters may be applied to different pixel classes in order to improve the quality of the reproduced image.

[0045] As discussed above, the image data comprises multiple scan lines of pixel image data and each scan line typically includes intensity

information for each pixel within the scan line. Typical image types include graphics, text, low-frequency halftone, high frequency contone, and the like.

[0046] Control begins in step S100 and continues to step S107. In step S101, micro-detection is carried out. During micro-detection, multiple scan lines of image data are buffered into memory. Each pixel is examined and a preliminary determination is made as to the image type of the pixel. In addition, the intensity of each pixel is compared to the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding neighboring pixels. When a pixel has a significantly different intensity than its neighboring surrounding pixels, the pixel is classified as an edge pixel.

[0047] Next in step S103, macro-detection is performed. The results of the micro-detection step are used to identify those pixels within each scan line that are edges and those pixels that belong to image runs. The image type of each image run is then determined based on the micro-detection results. The image type of an image run may also be based on the image type and a confidence factor of an adjacent image run of a previous scan line. If information obtained during an image run of a previous scan line is not sufficient to classify the image run as a standard image type, but information generated during examination of the current scan line makes it possible to determine the image type of

the image run of the previous scan line, the determination of the image type of that image run is made. The image type of the image run of the previous scan line is then recorded.

[0048] An example of a single scan line of image data is shown in Fig. 7. During the macro-detection step, adjacent pixels having significantly different intensities from each other are classified as edges 754, 758 and 762. Portions of the scan line between the edges are classified as image runs 752, 756, 760 and 764. It should be understood that although the micro-detection step S101 and the macro-detection step S103 of the exemplary segmentation method are shown sequentially, it is possible to carry out the steps simultaneously.

[0049] Next in step S105, the image runs of adjacent scan lines are combined to form windows. It should be understood that the term windows may be applied to portions of the scanned image which contain similarly classified pixels or portions of the obtain image which are connected. A graphical representation of multiple scan lines that have been grouped into windows is shown in Fig. 8. The image data has been separated into a first window 812 and a second window 813, separated by a gutter 811. A first edge 814 separates the first window 812 from the remainder of the image data. A second edge 816 separates the second window 813 from the remainder of the image data. In addition, a third edge 818 separates the second window 813 into a first portion 824 and a second portion 826 each having different image types.

[0050] Next in step S107, statistics are gathered and calculated for each of the windows and the pixels of the scanned image. The statistics are based on the intensity and macro-detection results for each of the pixels within a window.

[0051] Next in step S109, the statistics are examined to classify each window and each pixel of the scanned image.

[0052] At the end of the first pass, in step S111, the beginning point and the image type of each of the windows and/or the classification tag of each pixel are recorded.

[0053] Next in step S113, the pixels classifications are used to process the image data accordingly. For example, during processing of the image data, different filters may be applied to the data based on the classification of the pixel being processed. Control proceeds to step S115 where the process ends.

[0054]

As discussed above, various exemplary embodiments of the invention may be used in conjunction with any known or hereafter developed image segmentation and/or pixel classification systems and methods, such as, the exemplary systems and methods described above. Irrespective of the system or method used, each pixel of a scanned image is generally classified into one of several types of classes, such as, text, background, smooth contone, rough contone, halftones of different frequencies, and the like. Various exemplary embodiments of the invention use full-page background detection results to challenge

the classification of a pixel and to adjust/reclassify, as necessary, the classification of the pixel.

[0055] It should be understood that preferably, in various exemplary embodiments of the invention, the full-page background detection results may be used to check the classification of a pixel prior to the labeling of the pixel.

[0056] Various exemplary embodiments of the invention may be incorporated into the exemplary segmentation and processing method described above. In particular, various exemplary embodiments of the invention use the results of a full page based background detection to adjust, as necessary, the classification of the pixels by checking the classification. Various exemplary embodiments of the invention check the classification of a pixel by comparing the intensity of the pixel with the intensity of the white point or the background intensity level of the image. The white point or the background intensity level of the image is determined based on an analysis of substantially all of the pixels of the document, and not just a sampling of the pixels or a sub-region of the image.

[0057] Fig. 9 is a flowchart outlining an exemplary method for classifying pixels of an image. It should be understood that although the steps are illustrated sequentially, the various steps may occur simultaneously and/or in any order.

[0058]

Control begins in step S900 and continues to step S910. In step

S910, the background intensity level of the image is determined. As discussed above, the background intensity level is based on substantially all of the pixels of the image. Next, in step S920, the pixels of the image are classified. Then, in step S930, the classification of each pixel is checked based on the determined background intensity level of the image. More particularly, in step S930 the classification of pixels classified as a pixel class eligible for reclassification, such as smooth contone and background, are checked.

[0059] When, for example, the intensity of a pixel classified as background is less than the intensity of a determined white point of the image, the pixel is reclassified as smooth contone in step S940. Conversely, when, for example, the intensity of a pixel is classified as background is not less than the intensity of a determined white point of the image, the pixel's classification is confirmed as background and is not modified.

[0060] When, for example, the intensity of a pixel classified as smooth contone is not less than the intensity of the white point of the image, the pixel is reclassified as background in S940. Conversely, when, for example, the intensity of a pixel is classified as smooth contone is less than the intensity of a determined white point of the image, the pixel's classification is confirmed as smooth contone and is not modified.

[0061] In various exemplary embodiments of the invention, various contone based classes, such as, rough contone and smooth contone, are

eligible for classification and can be subjected to re-classification based on the background detection results of the scanned image.

[0062] In some exemplary embodiments of the invention that are used in conjunction with systems and methods where micro-level classification is followed by macro-level classification (i.e., for example, image objects or "windows" are identified and classified, as described above), the classification of any or all of the pixels in both the non-window and window areas may be checked and adjusted, if necessary. That is, the results of a full page based background detection may be used to adjust, as necessary, the classification of any and/or all of the pixels.

[0063] In various exemplary embodiments of the invention, full-page based background detection results are used to check/adjust the classification of pixels for monochrome images and/or color images. Various exemplary embodiments of the invention provide a method for classifying pixels in which misclassification of a pixel can be substantially and preferably, completely eliminated. For example, the misclassification of a pixel as a background pixel instead of a smooth contone may be substantially and preferably, completely eliminated.

[0064] It should be understood that the computing unit 110, may be any known system capable of processing the data, such as, a special purpose computer, a programmed microprocessor or micro-controller and peripheral integrated circuit elements, an ASIC or other integrated circuit, a hardwired electronic or logic circuit such as a discrete

element circuit, a programmable logic device such as a PLD, PLA, FPGA or PAL, or the like. Specific algorithms may also be accomplished using software in combination with specific hardware.

[0065] While the invention has been described with reference to various exemplary embodiments disclosed above, various alternatives, modifications, variations, improvements and/or substantial equivalents, whether known or that are or may be presently unforeseen, may become apparent upon reviewing the foregoing disclosure. Accordingly, the exemplary embodiments of the invention, as set forth above, are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention.

Claims

[c1] A pixel classification method, comprising:

determining a background intensity level of an image, the background intensity level being based on substantially all of the pixels of the image;

classifying a pixel of the image; and

checking the classification of the pixel based on the determined background intensity level of the image.

[c2] The pixel classification method of claim 1, wherein the determining step comprises determining a white point of the image based on at least one characteristic of substantially all of the pixels of the image.

[c3] The pixel classification method of claim 2, wherein the checking step comprises comparing an intensity of the pixel with an intensity of the white point of the image.

[c4] The pixel classification method of claim 3, further comprising reclassifying the pixel as background when the pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image.

[c5] The pixel classification method of claim 3, further comprising reclassifying the pixel as one of smooth contone and an equivalent class when the pixel is classified as background and

the intensity of the pixel is less than the intensity of the white point of the image.

[c6] The pixel classification method of claim 1, wherein the determining step comprises identifies a spread of intensity levels of substantially all the pixels of the image and determining an intensity level of a majority of the pixels.

[c7] The pixel classification method of claim 4, wherein the pixel is classified as smooth contone.

[c8] A pixel classification apparatus, comprising:

a background intensity level determining module that determines a background intensity level of an image based on substantially all of the pixels of the image; and

an image processing module that classifies a pixel of the image, and checks the classification of the pixel based on the determined background intensity level of the image.

[c9] The pixel classification apparatus of claim 8, wherein the background intensity level determining module determines a white point of the image based on a characteristic of substantially all of the pixels of the image.

[c10] The pixel classification apparatus of claim 9, wherein the image processing module checks the classification of the pixel by comparing the intensity of the pixel with the intensity of the white point of the image.

[c11] The pixel classification apparatus of claim 10, wherein when a pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

[c12] The pixel classification apparatus of claim 10, wherein when a pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

[c13] The pixel classification apparatus of claim 1, wherein the image processing module identifies a spread of intensity levels of substantially all the pixels of the image and determines an intensity level of a majority of the pixels.

[c14] The pixel classification apparatus of claim 11, wherein the pixel is classified as one of smooth contone and an equivalent class.

[c15] An image processing method, comprising:

determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image;

classifying a pixel of the image;

checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image;

reclassifying pixels based on results of the checking step;

and

processing image data of the pixels of the image based on the classification of the pixels.

[c16] The image processing method of claim 15, further comprising storing a label associated with each of substantially all of the pixels, wherein the label of each of substantially all of the pixels is based on results of the classification step and the checking step for the pixel.

[c17] The image processing method of claim 15, wherein classifying a pixel of the image comprises classifying the pixel as one of smooth contone, rough contone, text, background, graphics and halftone.

[c18] The image processing method of claim 15, wherein the determining step comprises determining a white point of the image based on a characteristic of substantially all of the pixels of the image.

[c19] The image processing method of claim 18, wherein the checking step comprises comparing an intensity of the pixel with an intensity of the white point of the image.

[c20] The image processing method of claim 19, wherein when the pixel is classified as smooth contone and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

[c21] The image processing method of claim 19, wherein when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

[c22] The image processing method of claim 15, wherein the portion of the pixels comprises substantially all of the pixels of the image.

SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

Abstract

A pixel classification method for classifying pixels of an image by determining a background intensity level of an image which is based on substantially all of the pixels of the image. The method also involves classifying the pixels of the image and checking the classification of the pixel based on the determined background intensity level of the image.

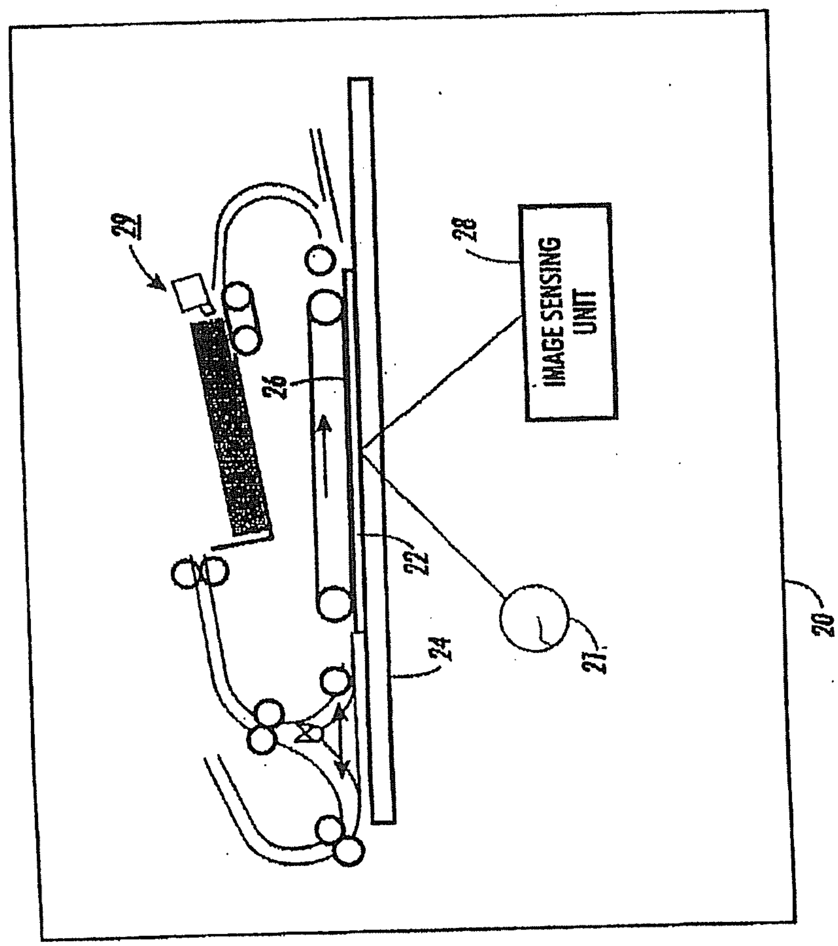
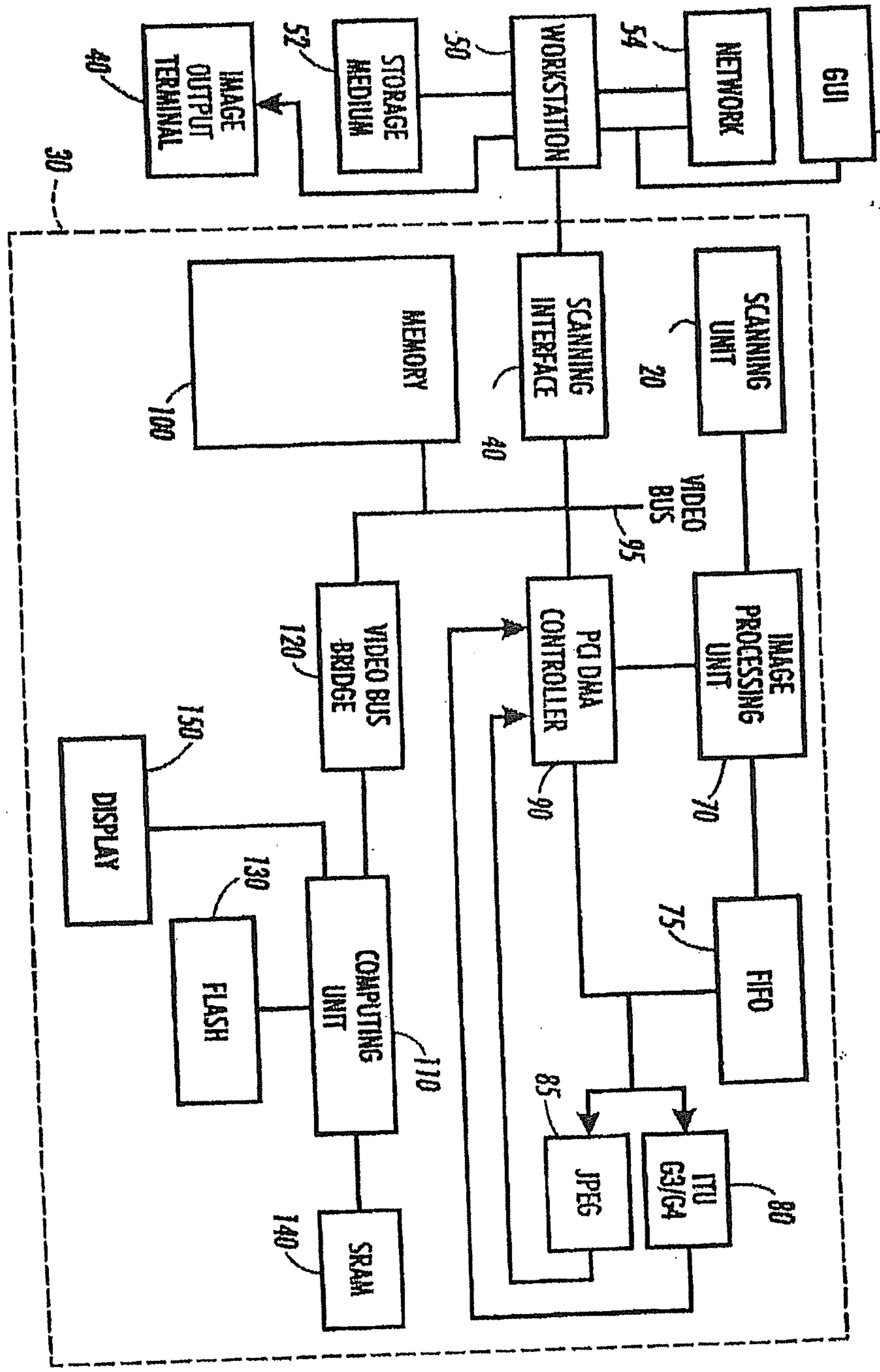


FIG. 1



GUI
160
NETWORK
54
WORKSTATION
50
STORAGE MEDIUM
52
IMAGE OUTPUT TERMINAL
40
30
SCANNING UNIT
20
SCANNING INTERFACE
40
MEMORY
100
VIDEO BUS
95
IMAGE PROCESSING UNIT
70
PCI DMA CONTROLLER
90
VIDEO BUS BRIDGE
120
FIFO
75
ITU G3/G4
80
JPEG
85
COMPUTING UNIT
110
FLASH
130
DISPLAY
150
SRAM
140

FIG. 2

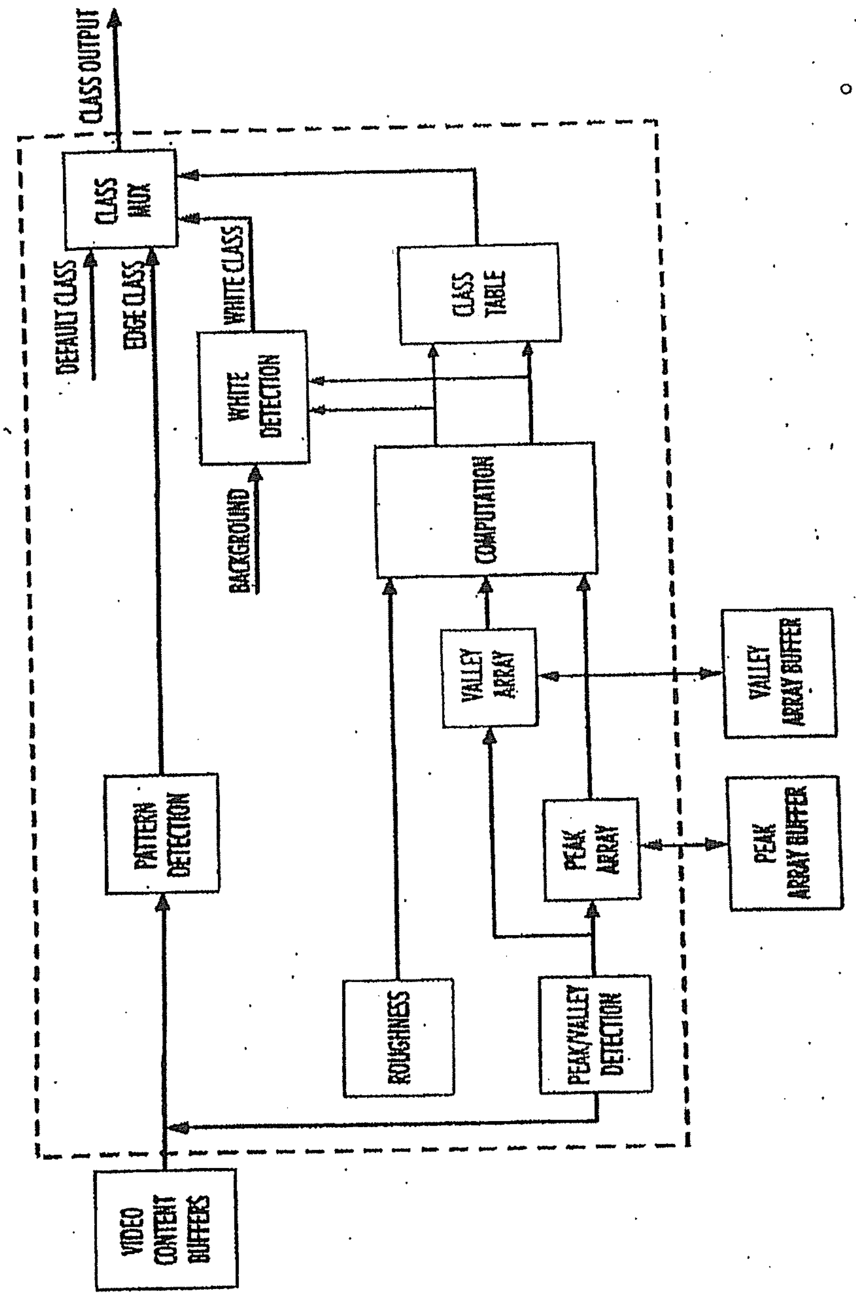

CLASS OUTPUT
CLASS MUX
DEFAULT CLASS
EDGE CLASS
WHITE CLASS
CLASS TABLE
WHITE DETECTION
BACKGROUND
COMPUTATION
VALLEY ARRAY
VALLEY ARRAY BUFFER
PATTERN DETECTION
PEAK ARRAY
PEAK ARRAY BUFFER
ROUGHNESS
PEAK/VALLEY DETECTION
VIDEO CONTENT BUFFERS

FIG. 3

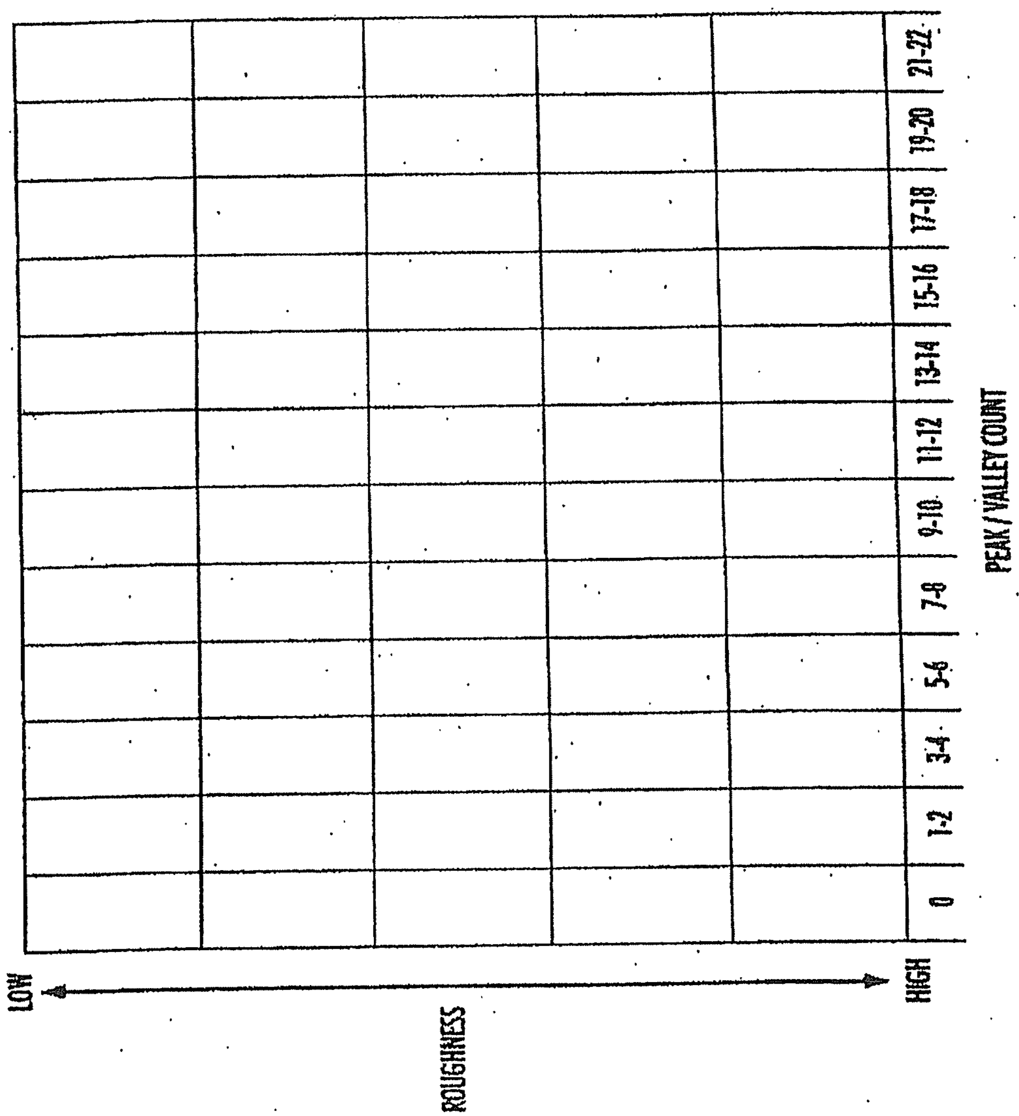

LOW
HIGH
ROUGHNESS
0
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
PEAK / VALLEY COUNT

FIG. 4

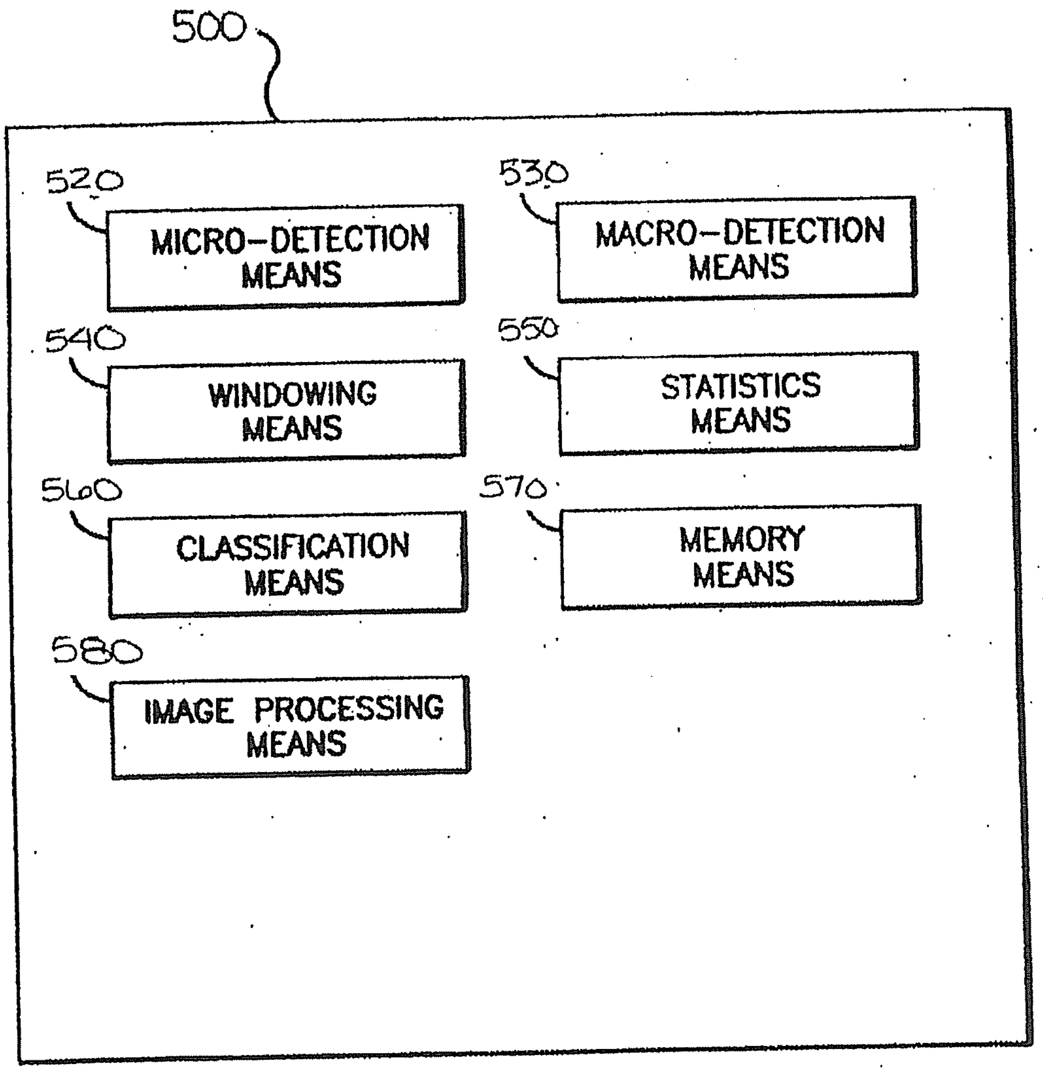

500
520
MICRO-DETECTION MEANS
530
MACRO-DETECTION MEANS
540
WINDOWING MEANS
550
STATISTICS MEANS
560
CLASSIFICATION MEANS
570
MEMORY MEANS
580
IMAGE PROCESSING MEANS

FIG. 5

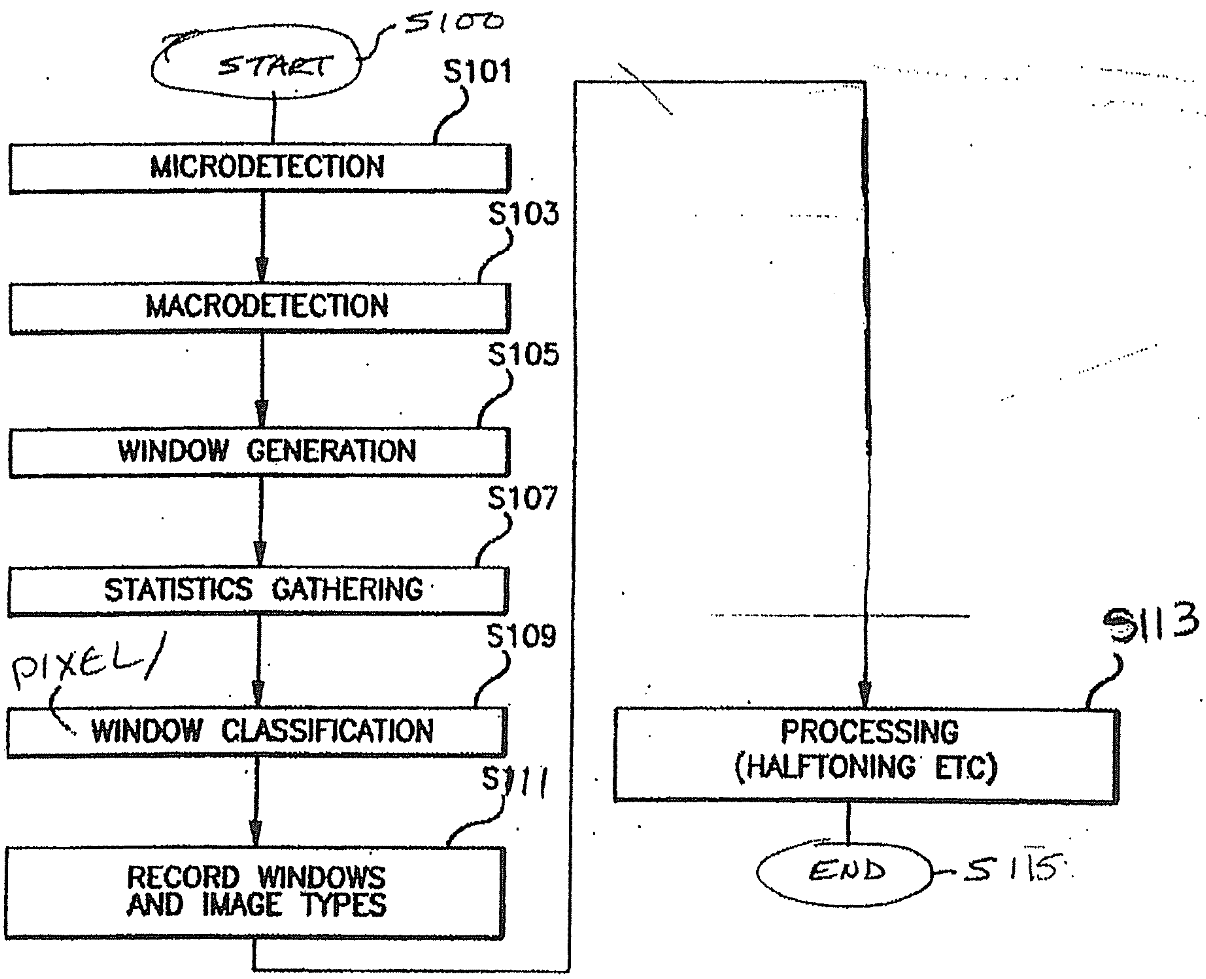

START
S100
S101
MICRODETECTION
S103
MACRODETECTION
S105
WINDOW GENERATION
S107
STATISTICS GATHERING
S109
PIXEL/
WINDOW CLASSIFICATION
S111
RECORD WINDOWS AND IMAGE TYPES
S113
PROCESSING (HALFTONING ETC)
END
S115

FIG. 6

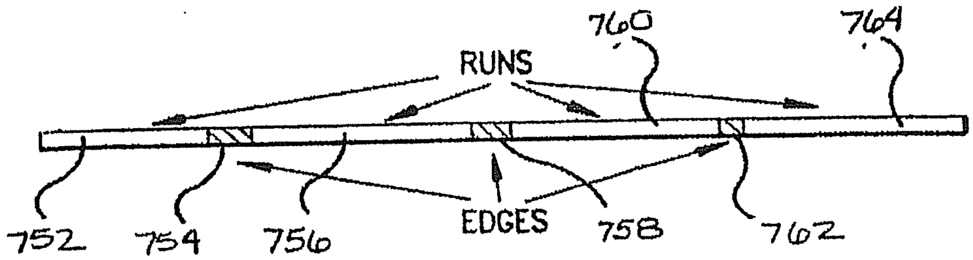


FIG. 7

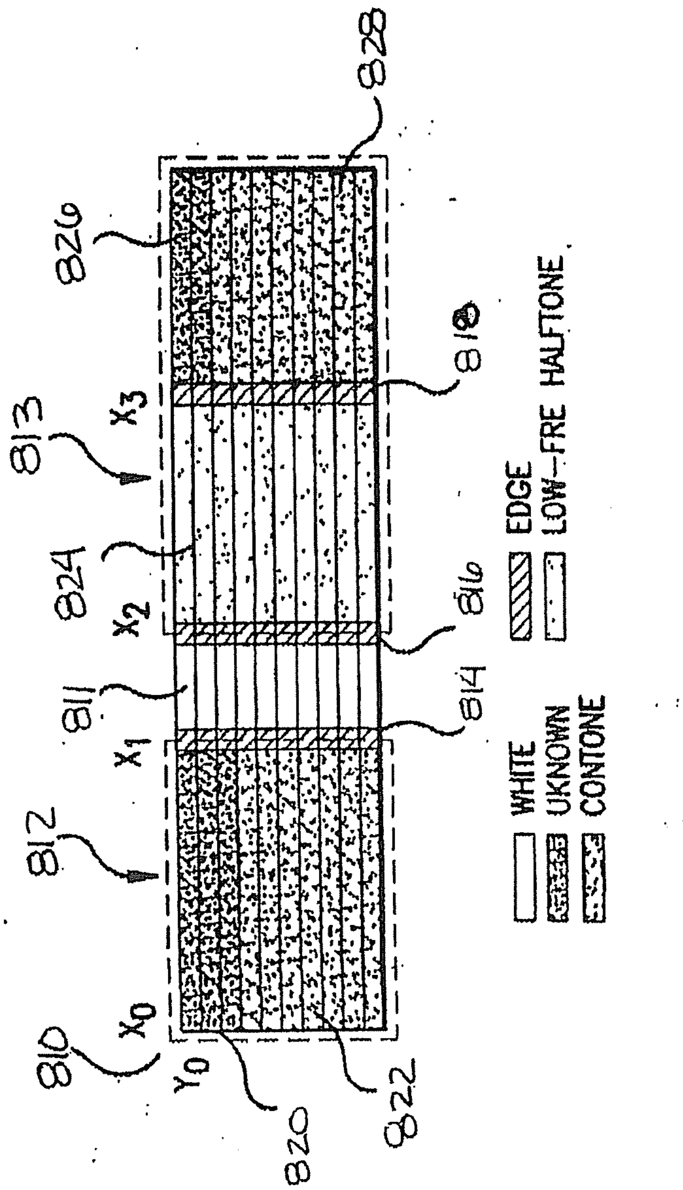

810
812
813
811
814
816
818
820
822
824
826
828
X0
X1
X2
X3
Y0
WHITE
UKNOWN
CONTONE
EDGE
LOW-FRE HALFTONE

FIG. 8

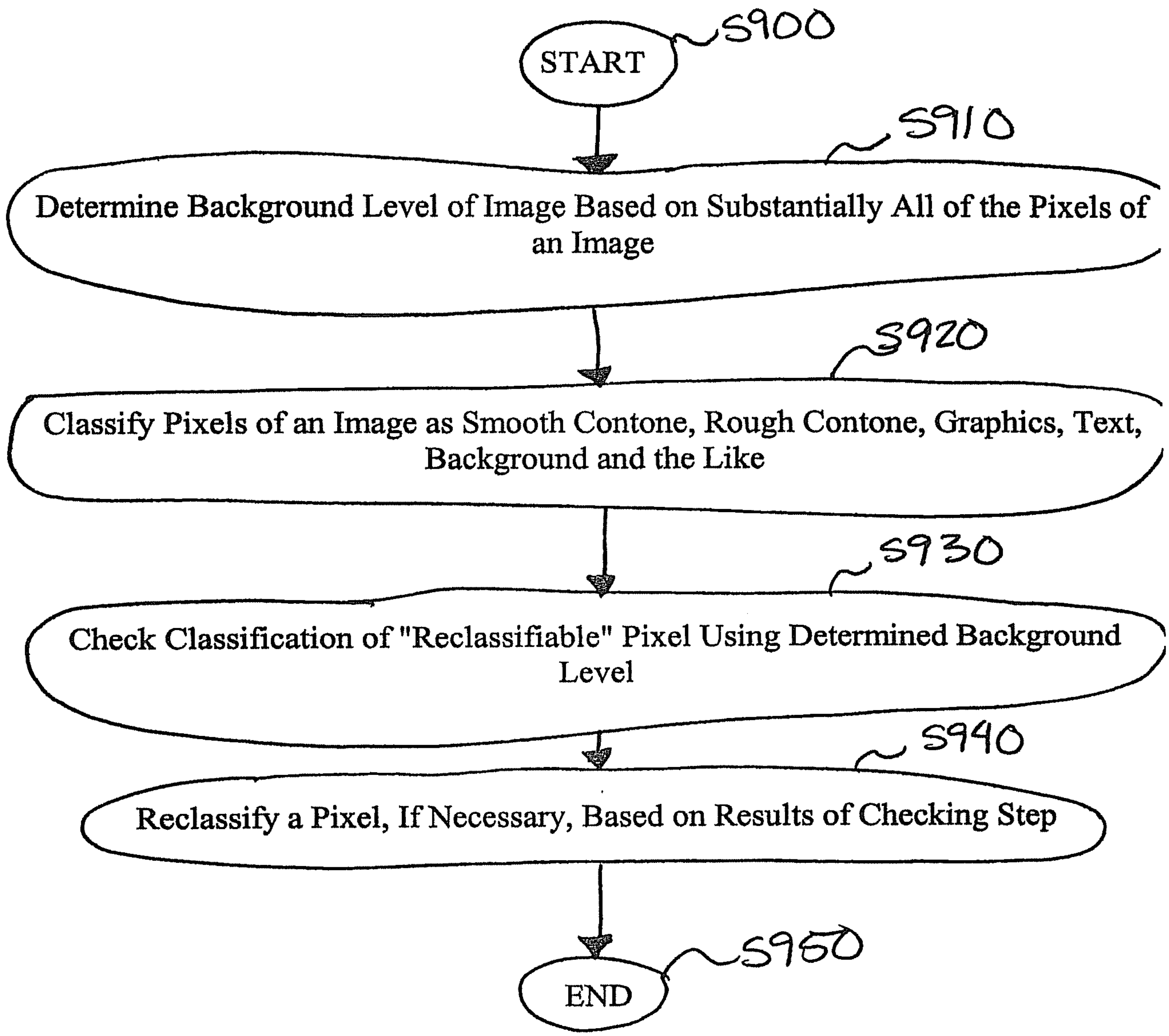

S900
START
S910
Determine Background Level of Image Based on Substantially All of the Pixels of an Image
S920
Classify Pixels of an Image as Smooth Contone, Rough Contone, Graphics, Text, Background and the Like
S930
Check Classification of "Reclassifiable" Pixel Using Determined Background Level
S940
Reclassify a Pixel, If Necessary, Based on Results of Checking Step
S950
END

FIG. 9

Xerox Docket No. D/A3648

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Xing LI et al. Group Art Unit: 2624

Application No.: 10/709,833 Examiner: A. WOLDEMARIAM

Filed: June 1, 2004 Docket No.: 119021

For: SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In reply to the September 4, 2008 Office Action, please consider the following:

Amendments to the Claims as reflected in the listing of claims; and

Remarks.

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A pixel classification method, comprising:

determining a background intensity level of an image, the background intensity level being based on substantially all of the pixels of the image;

classifying a pixel of the image~~ without adjusting an intensity of the pixel~~;

confirming the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level;

determining if reclassification is required; and

reclassifying the pixel when reclassification is required.

2. (Original) The pixel classification method of claim 1, wherein the determining step comprises determining a white point of the image based on at least one characteristic of substantially all of the pixels of the image.

3. (Previously Presented) The pixel classification method of claim 2, wherein the confirming step comprises comparing the intensity of the pixel with an intensity of the white point of the image.

4. (Previously Presented) The pixel classification method of claim 3, wherein the reclassifying step includes reclassifying the pixel as background when the pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image.

5. (Previously Presented) The pixel classification method of claim 3, wherein the reclassifying step includes reclassifying the pixel as one of smooth contone and an equivalent

class when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image.

6. (Previously Presented) The pixel classification method of claim 1, wherein the determining step comprises identifying a spread of intensity levels of substantially all the pixels of the image and determining an intensity level of a majority of the pixels.

7. (Original) The pixel classification method of claim 4, wherein the pixel is classified as smooth contone.

8. (Currently Amended) A pixel classification apparatus, comprising:

a background intensity level determining module that determines a background intensity level of an image based on substantially all of the pixels of the image; and

an image processing module that classifies a pixel of the image,~~image without adjusting an intensity of the pixel,~~ confirms the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level, determines if reclassification is required, and reclassifies the pixel when reclassification is required.

9. (Original) The pixel classification apparatus of claim 8, wherein the background intensity level determining module determines a white point of the image based on a characteristic of substantially all of the pixels of the image.

10. (Previously Presented) The pixel classification apparatus of claim 9, wherein the image processing module confirms the classification of the pixel by comparing the intensity of the pixel with the intensity of the white point of the image.

11. (Original) The pixel classification apparatus of claim 10, wherein when a pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

12. (Original) The pixel classification apparatus of claim 10, wherein when a pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

13. (Previously Presented) The pixel classification apparatus of claim 8, wherein the image processing module identifies a spread of intensity levels of substantially all the pixels of the image and determines an intensity level of a majority of the pixels.

14. (Original) The pixel classification apparatus of claim 11, wherein the pixel is classified as one of smooth contone and an equivalent class.

15. (Original) An image processing method, comprising:

determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image;

classifying a pixel of the image;

checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image;

reclassifying pixels based on results of the checking step; and

processing image data of the pixels of the image based on the classification of the pixels.

16. (Original) The image processing method of claim 15, further comprising storing a label associated with each of substantially all of the pixels, wherein the label of each of substantially all of the pixels is based on results of the classification step and the checking step for the pixel.

17. (Original) The image processing method of claim 15, wherein classifying a pixel of the image comprises classifying the pixel as one of smooth contone, rough contone, text, background, graphics and halftone.

18. (Original) The image processing method of claim 15, wherein the determining step comprises determining a white point of the image based on a characteristic of substantially all of the pixels of the image.

19. (Original) The image processing method of claim 18, wherein the checking step comprises comparing an intensity of the pixel with an intensity of the white point of the image.

20. (Original) The image processing method of claim 19, wherein when the pixel is classified as smooth contone and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background.

21. (Original) The image processing method of claim 19, wherein when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone.

22. (Original) The image processing method of claim 15, wherein the portion of the pixels comprises substantially all of the pixels of the image.

REMARKS

Claims 1-22 are pending. By this Amendment, claims 1 and 8 are amended. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

The courtesies extended to Applicants' representatives by Examiner Woldemariam at the interview held November 5, are appreciated. The reasons presented at the interview as warranting favorable action are incorporated into the remarks below and constitute Applicants' record of the interview.

Claims 1 and 8 stand rejected under 35 U.S.C. §112, first paragraph as containing subject matter which was not described in the specification. Claims 1 and 8 are amended to obviate the rejection. Withdrawal of the rejection is respectfully requested.

Claims 1-22 stand rejected under 35 U.S.C. §103(a) over Lin (U.S. Patent Publication No. 2002/0076103 A1) in view of "Applicants' admitted prior art." The rejection is respectfully traversed.

The Office Action recognizes that Lin does not disclose the "...background intensity level...based on substantially all of the pixels of the image..." feature of independent claims 1 and 8. However, the Office Action asserts that (1) the disclosure in the background section that "[c]onventionally, background detection is performed by sampling pixel values either with a sub-region of the document (typically, the leading edge) or across the whole document" (emphasis added) correlates to the claimed feature, and (2) it would have been obvious to modify the Lin method and apparatus in a way that resulted in the combinations of features of claims 1 and 8. Applicants respectfully disagree.

The definition of "sampling" as used in Applicants' specification is commonly understood to refer to "a small portion, pieces, or segment."[1] This conventional method of determining intensity level of an image based on sampling pixel values is not..."a pixel classification...based on substantially all of the pixels of the image..." as recited in claims 1 and 8. Thus, "Applicants' admitted prior art" would not have motivated one having ordinary skill in the art at the time of the invention to modify Lin to obtain the "substantially all of the pixels" feature recited in claims 1 and 8.

Furthermore, Lin teaches away from the possibility of the claims 1 and 8 feature of "determining if reclassification is required..." since at the time Lin makes a first pass of the image Lin does not record the macro-detection or micro-detection results for each pixel of the image. See Paragraph [0060] of Lin. More specifically, because Lin does not record the macro-detection or micro-detection results for each pixel, it is impossible for each pixel to be reclassified, as recited in independent claims 1 and 8.

Regarding independent claim 15, Lin fails to disclose "determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image", and "checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image...." Lin classifies the intensity of each pixel based on the intensity of its surrounding pixels, not based on a background intensity level that is based on substantially all of the pixels of the image. See Lin Paragraph [0053]. Thus, one having ordinary skill in the art would not have modified Lin in view of Applicants' "admitted prior art" to obtain the combination of features recited in claim 15.

[1] American Heritage College Dictionary, fourth edition, page 1228.

Claims 2-7, 9-14 and 16-22 are patentable for at least the reasons mentioned above with respect to claims 1, 8 and 15. Withdrawal of the rejection is requested.

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Robert G. Bachner
Registration No. 60,122

JAO:RGB/jls

Date: November 12, 2008

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/709,833	06/01/2004	Xing LI	119021	3832

27074 7590 02/10/2009
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P.O. BOX 320850
ALEXANDRIA, VA 22320-4850

EXAMINER	
WOLDEMARIAM, AKILILU K	
ART UNIT	PAPER NUMBER
2624	

NOTIFICATION DATE	DELIVERY MODE
02/10/2009	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

OfficeAction27074@oliff.com
jarmstrong@oliff.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)
	10/709,833	LI ET AL.
	Examiner	**Art Unit**
	AKLILU k. WOLDEMARIAM	2624

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/12/2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *01 June 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *06/01/2004*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Applicant's amendment field 11/12/2008 has been entered. Claims 1 and 8 have been amended. Clams 1-22 are still pending, with claims, 1, 8 and 15 being an independent.

Response to Arguments

2. Applicant's arguments field 11/12/2008 have been respectfully considered, but they are not persuasive. Examiner disagreed with applicant arguments, in claims 1 and 8, claim limitations, "background intensity level based on substantially all of the pixels of the image and a pixel classification based on substantially all of the pixels of the image." Because Applicant's admitted prior art discloses background intensity level based on substantially all of the pixels of the image *(conventionally background detection is performed by sampling pixel values either with a sub-region of the document or across the whole document (i.e., being based on substantially all of the pixel values (intensity level) of the image (see paragraph [0012])* and Lin discloses a pixel classification based on substantially all of the pixels of the image (*see item 46, fig. 7 classification means and paragraph [0057] the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types and substantially referred to pixels size or pixel amount). Examiner disagreed with applicant's argument with claim 15 for above similar or identical reasons. Please see list of references by examiner.*

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin et al., "Lin" (U.S. Publication number 2002/0076103 A1) in view Applicant's admitted prior art" background section".

Regarding claims 1 and 8, *Lin discloses* a pixel classification method and apparatus *(see item 46, fig.7, classification means)*, comprising:

determining a background intensity level of an image *(see paragraph [0041], the output of the block based segmentation module 200 preferably is a three-layered mixed raster content file. Preferably, these layers represent background, foreground and [0047] and [0052] the image data comprises multiple scanlines of pixel image data, each scanline typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc).*

classifying a pixel of the image (*see item 46, fig. 7 classification means and paragraph [0057] the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types);* and

confirming the classification of the pixel based on the determined background intensity level of the image by comparing the intensity of the pixel with the determined background intensity level *(see paragraph [0053], each pixel is examined and preliminary determination is made as to the image type of the pixel. In addition, the intensity of each pixel is compared to the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding pixels);*

determining if reclassification is required; and reclassifying the pixel when reclassification is required *(see paragraph [0054] and [0059] pixel is within a window that was classified as "mixed" during the first pass, micro-detection, macro-detection and windowing steps performed during the second pass are used to assign an image type to the pixel).*

Lin does not disclose the background intensity level being based on substantially all of the pixels of the image. However, Applicant's admitted prior art discloses conventionally background detection is performed by sampling pixel values either with a sub-region of the document or across the whole document *(i.e., being based on substantially all of the pixel values (intensity level) of the image (see paragraph [0012])*

It would have been obvious to ordinary skill in the art at the time when the invention was made to use Applicant's admitted prior art teachings to modify Lin's method by detecting the background based on substantially all of the pixels' intensity level of the image in order to more accurately reproduce the image, [Applicant's admitted prior art see paragraph [0009] lines 6-10].

Regarding claim 2, *Lin discloses* the pixel classification method of claim 1, wherein the determining step comprises determining a white point of the image *(see paragraph [0071] like wise, a common type of image is text of different colors on a white background), and Applicants admitted prior art further discloses determining at least one characteristic (background of substantially all of the pixel values of the image (see paragraph [0012] conventionally, background detection is performed by sampling pixel values either within a sub-region of document (typically, the leading edge) or across the whole document) and combined method of Lin and Applicant's admitted prior art determining a white point of the image based on at least one characteristic of substantially all of the pixels of the image).*

Regarding claim 3, *Lin discloses* the pixel classification method of claim 2, wherein the checking confirming step comprises comparing the intensity of the pixel with an intensity of the white point of the image *(see paragraph [0052], [0053] and [0071] likewise, a common type image is text of different colors on a white background). Regarding claim 4, Lin further discloses the pixel classification method of claim 3, further comprising wherein the reclassifying step includes reclassifying the pixel as background when the pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image (see paragraph [0054], [0059] and [0071], likewise, a common type of image is text of different colors on a white back ground).*

Regarding claim 5, *Lin discloses* the pixel classification method of claim 3, further comprising wherein the reclassifying step includes reclassifying the pixel as one of

smooth contone and an equivalent class when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image *(see paragraph [0052], [0054], [0059] and [0071], likewise, a common type of image is text of different colors on a white back ground).*

Regarding claim 6, *Lin discloses* the pixel classification method of claim 1, wherein the identifies identifying a spread of intensity levels of the pixels of the image and determining step comprises determining an intensity level of a majority of the pixels *(see paragraph [0053] and [0056] statistics are gathered and calculated for each of the window. The statistics are based on the intensity and macro-detection results for each of the pixels within a window),*

Applicants admitted prior art further discloses sampling pixel values either within a sub-region (as disclosed by Lin) or across the whole document image [paragraph [0012] and the combined method of Lin and Applicant's admitted prior art is using the intensity level of substantially all pixels of the document.

Regarding claim 7, *Lin discloses* the pixel classification method of claim 4, wherein the pixel is classified as smooth contone *(see paragraph [0052] the image data comprises multiple typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc and paragraph [0057]).*

Regarding claim 9, *Lin discloses* the pixel classification apparatus of claim 8, wherein the background intensity level determining module determines a white point of the image *(see paragraph [0041] the output of the block based segmentation module*

200 preferably is a three-layered mixed raster content file. Preferably, these layers represent background, foreground and selectors fields and paragraph [0052] intensity and paragraph [0071] Likewise, a common type of image is text of different colors on a white background) and Applicant admitted prior art further discloses based on a characteristic of substantially all of the pixels of the image (see paragraph [0012] conventionally, background detection is performed by sampling pixel values either within a sub-region of document (typically, the leading edge) or across the whole document).

Regarding claim 10, *Lin discloses* the pixel classification apparatus of claim 9, wherein the image processing module cheeks confirms the classification of the pixel by comparing the intensity of the pixel with the intensity of the white point of the image *(see paragraph [0053], In addition, the intensity of each pixel is compared to the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding pixels and paragraph [0071] likewise, a common type of image is text of different colors on a white background).*

Regarding claim 11, *Lin discloses* the pixel classification apparatus of claim 10, wherein when a pixel is classified as a class eligible to be reclassified and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background *(see paragraph [0052], [0053], [0054] and [0071], Likewise, a common type of image is text of different colors on a white background).*

Regarding claim 12, *Lin discloses* the pixel classification apparatus of claim 10, wherein when a pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone *(see paragraph [0052], [0053], [0054] and [0059] pixel is within a window that was classified as "mixed" during the first pass, the micro-detection, macro-detection and windowing steps performed during the second pass are used to assign an image type to pixel).*

Regarding claim 13 refer to claim 6 rejection.

Regarding claim 14, *Lin discloses* the pixel classification apparatus of claim 11, wherein the pixel is classified as one of smooth contone and an equivalent class *(see paragraph [0053] and [0057] the image data comprises multiple scanlines of pixel image data, each scanline typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc).*

Regarding claim 15, *Lin discloses* an image processing method, comprising: determining a background intensity level of an image *(see paragraph [0041], the output of the block based segmentation module 200 preferably is a three-layered mixed raster content file. Preferably, these layers represent background, foreground and [0047] and [0052] the image data comprises multiple scanlines of pixel image data, each scanline typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc); classifying a pixel of the image (see item 46, fig. 7 classification means and*

paragraph [0057] the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types); and without adjusting an intensity of the pixel (see items 306 and 308, fig. 5,, reduced resolution is not reducing pixel intensity, reducing resolution by definition is reducing the number of pixel in image and not the pixel values);

checking the classification of at least a portion of the pixels of the image based on the determined background intensity level of the image *(see paragraph [0053], each pixel is examined and preliminary determination is made as to the image type of the pixel. In addition, the intensity of each pixel is compared to the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding pixels);*

reclassifying pixels based on results of the checking step *(see paragraph [0054] and [0059] if a pixel is within a window that was classified as "mixed" during the first pass, micro-detection, macro-detection and windowing steps performed during the second pass are used to assign an image type to the pixel); and processing image data of the pixels of the image based on the classification of the pixel (see paragraph [0063] the page segmentation and classification means 40 may also include image processing means 48 for processing the image data after each of the pixels has been labeled with an image type and as belonging to a particular window).*

Lin does not disclose the background level being based on substantially all of the pixels of the image. However, Applicant's admitted prior art discloses conventionally background detection is performed by sampling pixel values either with a sub-region of the document or across the whole document *(i.e., being based on substantially all of the pixel values (intensity level) of the image (see paragraph [0012]).*

It would have been obvious to ordinary skill in the art at the time when the invention was made to use Applicant's admitted prior art teachings to modify Lin's method by detecting the background based on substantially all of the pixels' intensity level of the image in order to more accurately reproduce the image, [Applicant's admitted prior art see paragraph [0009] lines 6-10].

Regarding claim 16, *Lin discloses* the image processing method of claim 15, further comprising storing a label associated with each of the pixels, wherein the label of each of the pixels is based on results of the classification step and the checking step for the pixel (*see paragraph [0063] and [0064] classification means 40 may also include image processing means 48 for processing the image data after each of the pixels has been labeled with an image type and the image data obtaining means 36 could include a scanner or device for reading a stored image from a memory. The device might also include image data generation means 38 for generating image data to be segmented and classified by the two pass method)),*

Applicants admitted prior art further discloses sampling pixel values either within a sub-region (as disclosed by Lin) or across the whole document image {paragraph [0012]

and the combined method of Lin and Applicant's admitted prior art is using substantially all pixels of the document.

Regarding claim 17, *Lin discloses* the image processing method of claim 15, wherein classifying a pixel of the image comprises classifying the pixel as one of smooth contone, rough contone, text, background, graphics and halftone *(see paragraph [0052] and [0057] the image data comprises multiple scanlines of pixel image data, each scanline typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc).*

Regarding claim 18, refer to claim 2 rejection.

Regarding claim 19, *Lin discloses* the image processing method of claim 18, wherein the checking step comprises comparing an intensity of the pixel with an intensity of the white point of the image *(see paragraph [0053] each pixel is examined and preliminary determination is made as to the image type of the pixel. In addition, the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding pixels and [0071], likewise, a common type of image is text of different colors on a white background).*

Regarding claim 20, *Lin discloses* the image processing method of claim 19, wherein when the pixel is classified as smooth contone and the intensity of the pixel is not less than the intensity of the white point of the image, the pixel is reclassified as background *(see paragraph [0052], [054] and [0057] the statistics are examined in an*

attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types. Windows that contain more than one type of image are classified as "mixed").

Regarding claim 21, *Lin discloses* the image processing method of claim 19, wherein when the pixel is classified as background and the intensity of the pixel is less than the intensity of the white point of the image, the pixel is reclassified as smooth contone *(see paragraph [0052], [054] and [0057] the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types. Windows that contain more than one type of image are classified as "mixed").*

Regarding claim 22, *Applicant's admitted prior art further* discloses the image processing method of claim 15, wherein the portion of the pixels comprises substantially all of the pixels of the image *(see paragraph [0012] conventionally, background detection is performed by sampling pixel values either within a sub-region of document (typically, the leading edge) or across the whole document).*

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to AKLILU k. WOLDEMARIAM whose telephone number is (571)270-3247. The examiner can normally be reached on Monday-Thursday 6:30 a.m-5:00 p.m EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on 571-272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Samir Ahmed
Examiner
Art Unit 2624

/A. k. W./
Examiner, Art Unit 2624
02/01/2009

/Brian Q Le/
Primary Examiner, Art Unit 2624

Xerox Docket No. D/A3648

PATENT APPLICATION

RESPONSE UNDER 37 CFR §1.116
EXPEDITED PROCEDURE
TECHNOLOGY CENTER ART UNIT 2624

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Xing LI et al.

Group Art Unit: 2624

Application No.: 10/709,833

Examiner: A. WOLDEMARIAM

Filed: June 1, 2004

Docket No.: 119021

For: SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

REQUEST FOR RECONSIDERATION AFTER FINAL REJECTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In reply to the February 10, 2009 Office Action, reconsideration of the rejection is respectfully requested in light of the following remarks.

REMARKS

Claims 1-22 are pending. Reconsideration in view of the following remarks is respectfully requested.

I. All Pending Claims are Patentable

Claims 1-22 stand rejected under 35 U.S.C. §103(a) over Lin (U.S. Patent Publication No. 2002/0076103) in view of Applicants' "admitted prior art background section". The rejection is respectfully traversed.

In responding to Applicants' arguments filed on November 12, 2008, the Office Action alleges that Applicants' Background section discloses determining the background intensity level based on substantially all of the pixels of the image and that Lin discloses a pixel classification based on substantially all the pixels of the image. Applicants respectfully disagree.

Applicants' Description of Related Art section discloses that "background detection is performed by sampling pixel values either within a sub-region of the document (typically, leading end) or across the whole documents" (emphasis added). The use of "sampling" in Applicants' specification is commonly understood to refer to "a small portion, pieces, or segment."[1] This conventional method of determining intensity level of an image based on sampling pixel values is not..."a pixel classification...based on substantially all the pixels of the image..." as recited in independent claims 1 and 8. Applicants' specification is consistent with this ordinary meaning of "sampling" in that Applicants' specification explicitly indicates that determining "based on substantially all the pixels..." is different from "sampling". See, for example, paragraphs [0012], [0014] and [0058] of the specification. Thus, "Applicants' admitted prior art" does not disclose that it was known to determine background intensity

[1] American Heritage College Dictionary, fourth edition, pages 1228

level based on "substantially all of the pixels" as recited in independent claims 1 and 8, and furthermore would not have motivated one having ordinary skill in the art at the time of the invention to modify Lin to obtain the combination of features recited in claims 1 and 8.

Additionally, Office Action does not respond to Applicants' argument that Lin teaches away from the claims 1 and 8 feature of "determining if reclassification is required..." since at the time Lin makes a first pass of the image Lin does not record the macro-detection or micro-detection results from the pixel of the image. See Lin paragraph [0060]. Specifically, because Lin does not record the macro-detection or micro-detection results of the pixel, it is impossible for each pixel to be reclassified, as recited in independent claims 1 and 8.

Regarding independent claim 15, Lin and "admitted prior art" fail to disclose or render obvious "determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image", and "checking the classification of at least a portion of pixels of the image based on the determined background intensity level of the image..." Lin classifies the intensity of each pixel based on the intensity of its surrounding pixels, not based on a background intensity level that is based on substantially all of the pixels of the image. See Lin paragraph [0053]. Thus, one having ordinary skill in the art would not have modified Lin in view of Applicants' "admitted prior art" to obtain the combination of features recited in claim 15.

Thus, claims 1, 8 and 15 are patentable. Accordingly, claims 2-7, 9-14 and 16-22 are also patentable for at least the reasons explained above with respect to claims 1, 8 and 15. Withdrawal of the rejection is requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of all pending claim are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Robert G. Bachner
Registration No. 60,122

JAO:RGB/jls

Date: March 10, 2009

OLIFF & BERRIDGE, PLC
P.O. Box 320850
Alexandria, Virginia 22320-4850
Telephone: (703) 836-6400

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/709,833	06/01/2004	Xing LI	119021	3832

27074 7590 04/14/2009
OLIFF & BERRIDGE, PLC.
P.O. BOX 320850
ALEXANDRIA, VA 22320-4850

EXAMINER	
WOLDEMARIAM, AKILILU K	
ART UNIT	PAPER NUMBER
2624	

NOTIFICATION DATE	DELIVERY MODE
04/14/2009	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

OfficeAction27074@oliff.com
jarmstrong@oliff.com

PTOL-90A (Rev. 04/07)

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 10/709,833	**Applicant(s)** LI ET AL.	
	Examiner AKLILU k. WOLDEMARIAM	**Art Unit** 2624	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 10 March 2009 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires ______months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on ______. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a)☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b)☐ They raise the issue of new matter (see NOTE below);
   (c)☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d)☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: *See Continuation Sheet*. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): ______.
6. ☐ Newly proposed or amended claim(s) ______ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☒ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: ______.
   Claim(s) objected to: ______.
   Claim(s) rejected: *1-22*.
   Claim(s) withdrawn from consideration: ______.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: ______.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). ______
13. ☒ Other: _____.

/Aklilu Woldemariam/

/Brian Q Le/
Primary Examiner, Art Unit 2624

Applicant argued that about references Lin (U.S. Patent Publication No. 2002/0076103 and Applicants' "admitted prior art background section", for example claim limitations, " background intensity level based on substantially all of the pixels of the image and a pixel classification based on substantially all of the pixels of the image", Examiner disgreed with applicant's argument,

bcause Applicant's admitted prior art discloses background intensity level based on substantially all of the pixels of the image (conventionally background detection is performed by sampling pixel values either with a sub-region of the document or across the whole document (i.e., being based on substantially all of the pixel values (intensity level) of the image (see paragraph [0012]) and Lin discloses a pixel classification based on substantially all of the pixels of the image (see item 46, fig. 7 classification means and paragraph [0057] the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types and substantially referred to pixels size or pixel amount).

Xerox Docket No. D/A3648

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Xing LI et al.	Group Art Unit: 2624
Application No.: 10/709,833	Examiner: A. WOLDEMARIAM
Filed: June 1, 2004	Docket No.: 119021

For: SYSTEMS AND METHODS FOR ADJUSTING PIXEL CLASSIFICATION USING BACKGROUND DETECTION

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This request is being filed with a Notice of Appeal. Review of the February 10, 2009 Final Rejection is requested for the reasons set forth in the attached five or fewer sheets.

Should any questions arise regarding this submission, or the Review Panel believe that anything further would be desirable in order to place this application in even better condition for allowance, the Review Panel is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Robert G. Bachner
Registration No. 60,122

JAO:RGB/jls

Date: May 1, 2009

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REMARKS

Claims 1-22 are pending. Review of the February 10, 2009 Final Rejection in view of the following remarks is respectfully requested.

Claims 1-22 stand rejected under 35 U.S.C. §103(a) over Lin (U.S. Patent Publication No. 2002/0076103) in view of Applicants' "admitted prior art background section". The rejection is improper and should be withdrawn.

The Final Rejection commits clear error when it asserts that Applicants' "admitted prior art background section" discloses that it was known to determine a background intensity level of an image "based on substantially all of the pixels of the image." Because the above-quoted feature is present in each of Applicants' independent claims (claims 1, 8 and 15), reversing the Examiner's decision should result in withdrawal of the rejection, which is the <u>only</u> rejection, and allowance of this application.

In responding to Applicants' arguments filed on November 12, 2008, the Office Action alleges that Applicants' Background section discloses that it was known to determine the background intensity level <u>based on substantially all of the pixels</u> of the image and that Lin discloses <u>a pixel classification</u> based on substantially all the pixels of the image. Applicants respectfully disagree.

Applicants' Description of Related Art section discloses that "background detection is performed by <u>sampling</u> pixel values either within a sub-region of the document (typically, leading end) or across the whole documents" (emphasis added). In particular, paragraph [0012] states:

> Conventionally, background detection is performed by sampling pixel values either within a sub-region of the document (typically, the leading edge) or across the whole document. For conventional processes, only a portion (i.e., not the full document) is used to detect the background of the document to be reproduced. The detected lead-edge or other sub-region background

> information is then used to process and classify each of the pixels of the scanned image.

The use of "sampling" in Applicants' specification is commonly understood to refer to "a small portion, pieces, or segment."[1] This conventional method of determining intensity level of an image based on sampling pixel values is not..."a pixel classification...based on substantially all the pixels of the image..." as recited in independent claims 1 and 8. "Sampling" is the antithesis of "substantially all." Applicants' specification is consistent with this ordinary meaning of "sampling" in that Applicants' specification explicitly indicates that determining "based on substantially all the pixels..." is different from "sampling". See, for example, paragraphs [0014] and [0056] of Applicants' specification (especially last sentence of paragraph [0056]), which are reproduced below.

> Various exemplary embodiments of the invention provide a pixel classification method for classifying pixels of an image by determining a background intensity level of an image which is based on substantially all of the pixels of the image. The method also involves checking the classification of the pixel based on the determined background intensity level of the image.
>
> Various exemplary embodiments of the invention may be incorporated into the exemplary segmentation and processing method described above. In particular, various exemplary embodiments of the invention use the results of a full page based background detection to adjust, as necessary, the classification of the pixels by checking the classification. Various exemplary embodiments of the invention check the classification of a pixel by comparing the intensity of the pixel with the intensity of the white point or the background intensity level of the image. The white point or the background intensity level of the image is determined based on an analysis of substantially all of the pixels of the document, and not just a sampling of the pixels or a sub-region of the image. (emphasis added)

Thus, "Applicants' admitted prior art" does not disclose that it was known to determine background intensity level based on "substantially all of the pixels" as recited in independent claims 1 and 8, and furthermore would not have rendered it obvious to one having ordinary

skill in the art at the time of the invention to modify Lin to obtain the combinations of features recited in claims 1 and 8.

Additionally, the Office Action does not respond to Applicants' argument that Lin teaches away from the claims 1 and 8 feature of "determining if reclassification is required..." because at the time Lin makes a first pass of the image, Lin does not record the macro-detection or micro-detection results from the pixel of the image. See Lin paragraph [0060], which states:

> Once each portion of the image data has been classified according to standard image types, further processing of the image data can be efficiently performed. Because the micro-detection and macro-detection results from the first pass are not recorded for each pixel of the image, the memory requirements for a device embodying the invention are minimized. This helps to minimize the cost of such an apparatus.

Applicants' specification explicitly acknowledges systems such as Lin's and distinguishes the features of the claims, for example, at paragraph [0013], which states:

> In known two-pass methods, for example, the original classification of a pixel as background is done during the first pass using lead-edge or other sub-region information and pixels classified as background during the first pass are not re-classified during the second pass. As lead-edge or other sub-region information may not be a true indication of the background of the captured image, misclassification of pixels as background can occur. For example, a background pixel can be classified as smooth contone or vise versa. Similarly, in known two-pass methods, pixels are subjected to a second pass when the pixel was associated with a "mixed" window during the first pass. Thus, in known classification methods, the classification of a pixel is not reconsidered. However, as discussed above, because it may be advantageous to classify pixels of different image types differently, the misclassification of a pixel as background, for example, can affect background suppression and also the rendering of the types of pixels.

Lin performs the pixel classification as explained in Applicants' Background of the Invention section. Thus, because Lin does not record the macro-detection or micro-detection results of

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[1] American Heritage College Dictionary, fourth edition, page 1228.

the pixel, it is impossible for each pixel to be reclassified, as recited in independent claims 1 and 8.

Regarding independent claim 15, Lin and "admitted prior art" fail to disclose or render obvious "determining a background intensity level of an image, the background level being based on substantially all of the pixels of the image", and "checking the classification of at least a portion of pixels of the image based on the determined background intensity level of the image..." Lin classifies the intensity of each pixel based on the intensity of its surrounding pixels, not based on a background intensity level that is based on substantially all of the pixels of the image. See Lin paragraph [0053]. As explained above, the "admitted prior art" also does not disclose this feature. Thus, one having ordinary skill in the art would not have modified Lin in view of Applicants' "admitted prior art" to obtain the combination of features recited in claim 15.

Thus, claims 1, 8 and 15 are patentable. Accordingly, claims 2-7, 9-14 and 16-22 are also patentable for at least the reasons explained above with respect to claims 1, 8 and 15. Withdrawal of the rejection is requested.

US 20020076103A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2002/0076103 A1

(43) Pub. Date: Jun. 20, 2002

Lin et al.

(54) METHOD AND APPARATUS FOR SEGMENTING AN IMAGE USING A COMBINATION OF IMAGE SEGMENTATION TECHNIQUES

(75) Inventors: **Ying-Wei Lin**, Penfield, NY (US); **Martin E. Banton**, Fairport, NY (US); **William A. Fuss**, Rochester, NY (US)

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(73) Assignee: **XEROX CORPORATION**

(21) Appl. No.: **09/737,515**

(22) Filed: **Dec. 15, 2000**

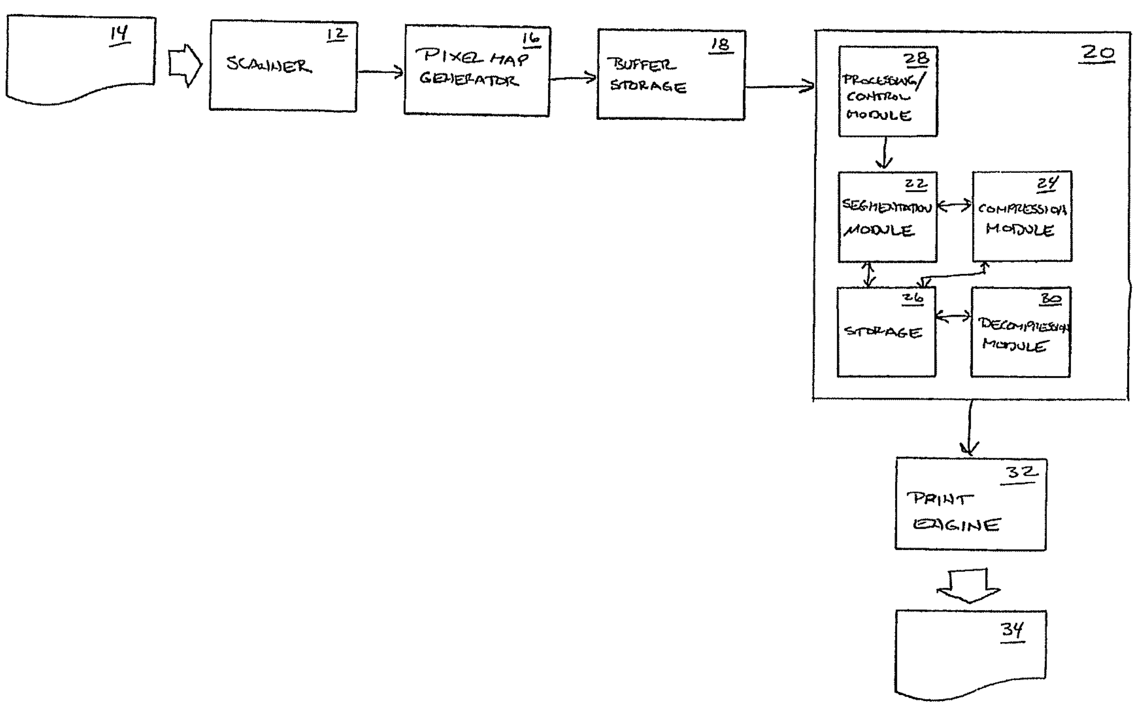
Publication Classification

(51) Int. Cl.[7] G06K 9/34

(52) U.S. Cl. 382/173

(57) ABSTRACT

This invention relates to a method and apparatus for segmenting an image using a combination of image segmentation techniques. More particularly, the invention is directed to an improved image segmentation technique for use in an image processing system that performs at least two distinct image segmentation processes on an image and combines the results to obtain a combined multi-layer representation of the image that can be suitably processed. In a specific example, a block based segmentation technique is performed on an image to generate a MRC (mixed raster content) representation—having foreground, background and selector layers. A pixel based segmentation technique is also performed on the image to generate rendering hints. The MRC representation and the rendering hints are then combined to obtain a four (4) layer representation of the image. The four layer representation is subsequently processed as required by the image processing system, e.g. compressed and stored.



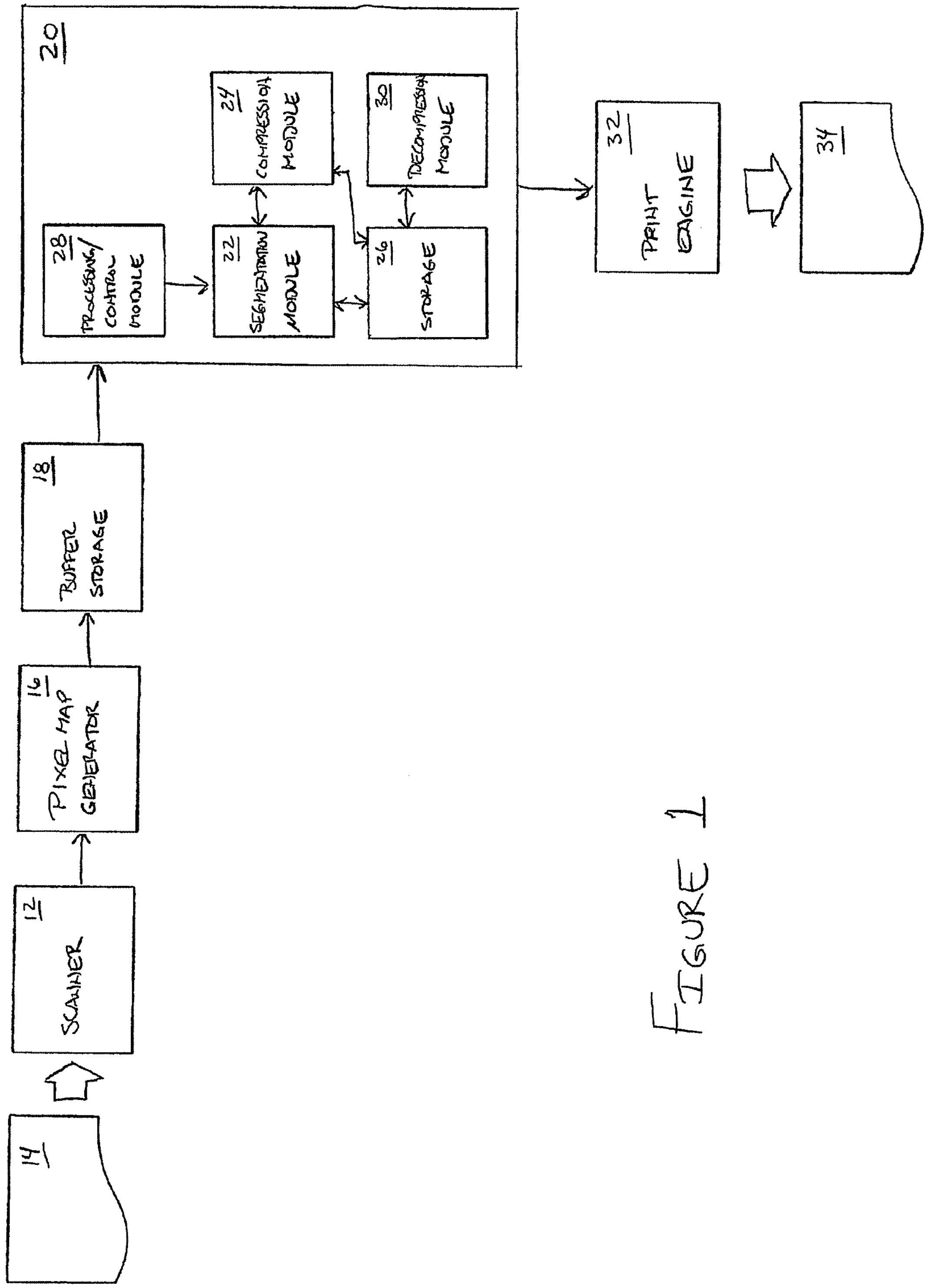

14
SCANNER
12
PIXEL MAP GENERATOR
16
BUFFER STORAGE
18
20
PROCESSING/CONTROL MODULE
28
SEGMENTATION MODULE
22
COMPRESSION MODULE
24
STORAGE
26
DECOMPRESSION MODULE
30
PRINT ENGINE
32
34

FIGURE 1

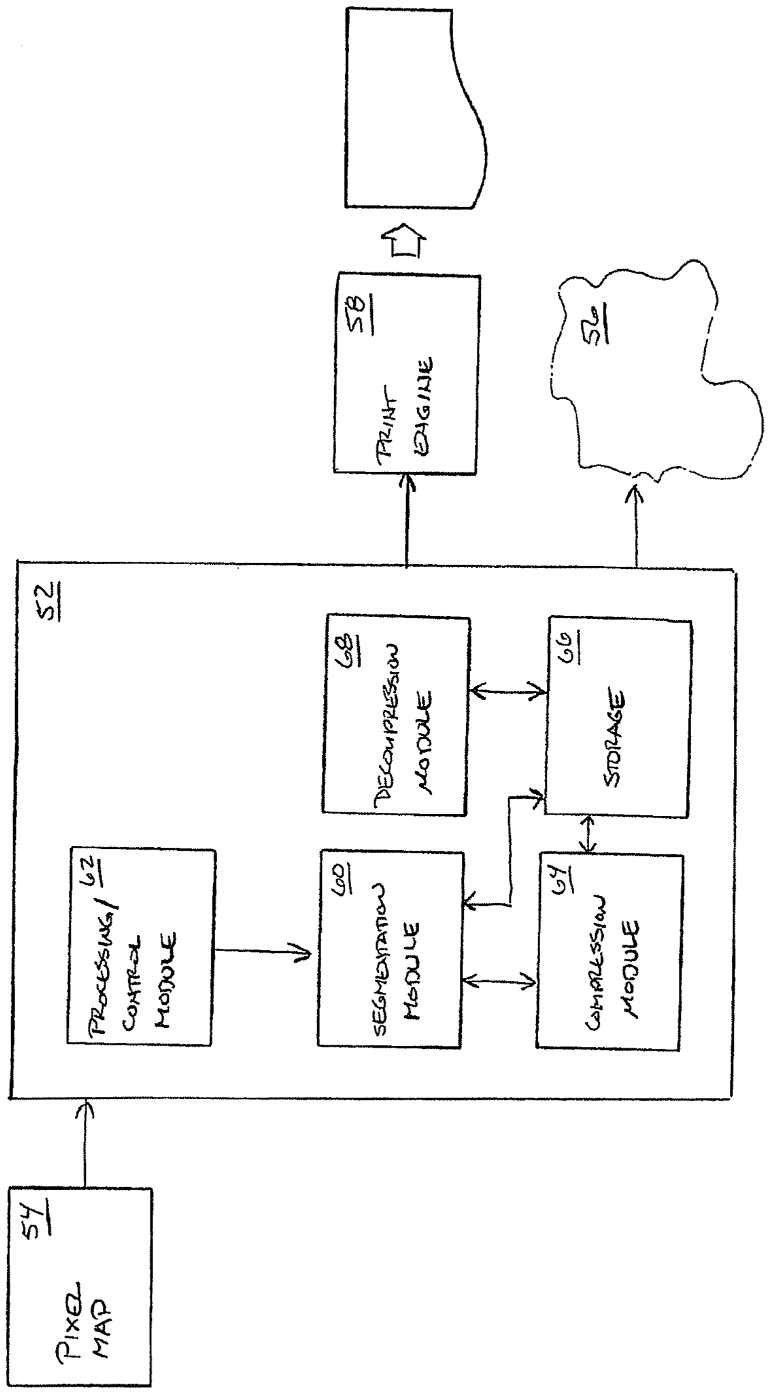

PIXEL MAP
54
52
PROCESSING/CONTROL MODULE
62
SEGMENTATION MODULE
60
COMPRESSION MODULE
64
DECOMPRESSION MODULE
68
STORAGE
66
PRINT ENGINE
58
56

FIGURE 2

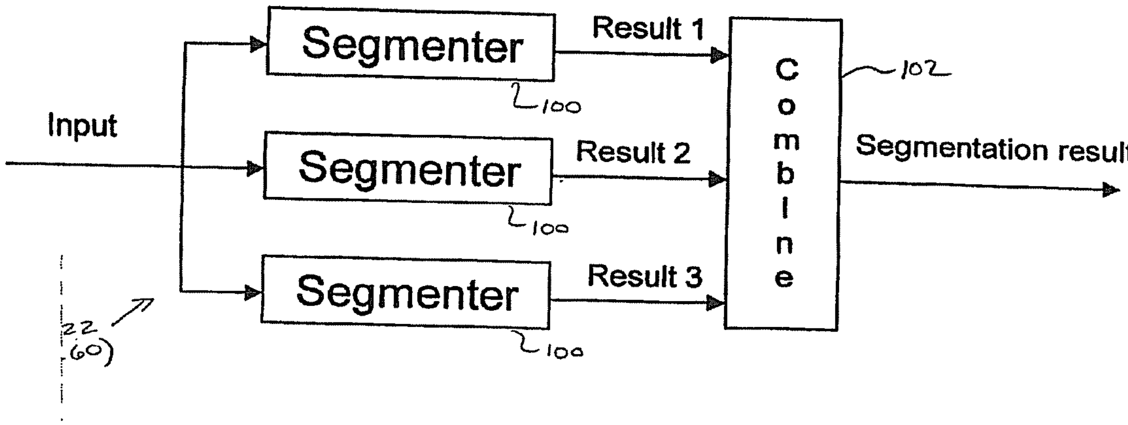

Segmenter
Segmenter
Segmenter
Result 1
Result 2
Result 3
Input
Combine
Segmentation result
102
100
100
100
22
60)

FIGURE 3

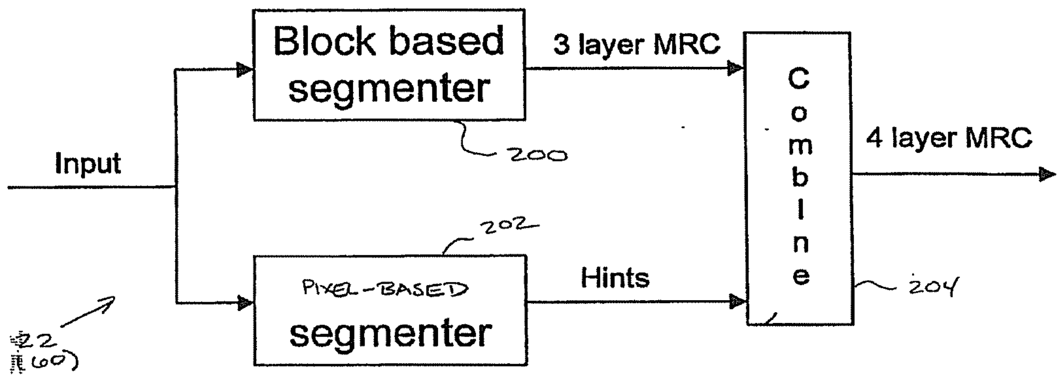

Block based segmenter
3 layer MRC
Combine
4 layer MRC
Input
200
202
PIXEL-BASED segmenter
Hints
204

FIGURE 4

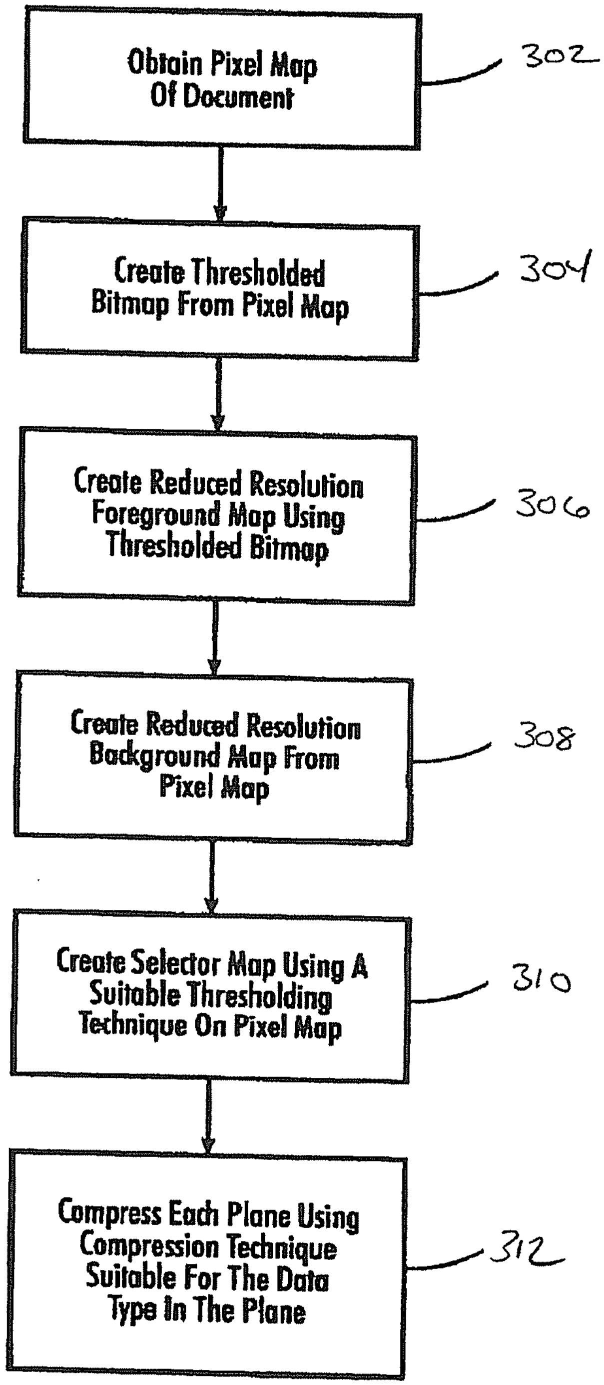

Obtain Pixel Map Of Document
302
Create Thresholded Bitmap From Pixel Map
304
Create Reduced Resolution Foreground Map Using Thresholded Bitmap
306
Create Reduced Resolution Background Map From Pixel Map
308
Create Selector Map Using A Suitable Thresholding Technique On Pixel Map
310
Compress Each Plane Using Compression Technique Suitable For The Data Type In The Plane
312

FIGURE 5

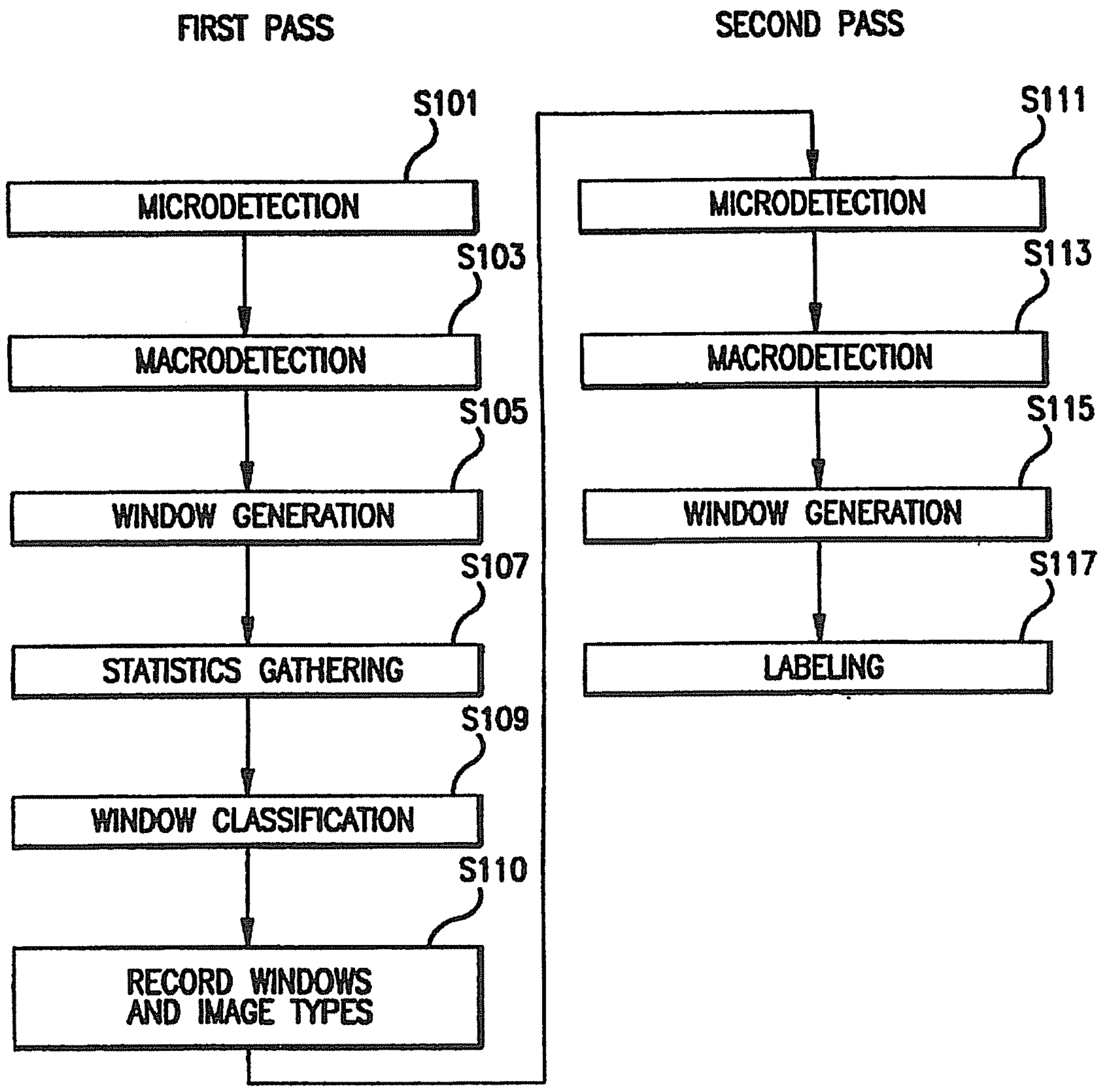

FIRST PASS
SECOND PASS
S101
MICRODETECTION
S103
MACRODETECTION
S105
WINDOW GENERATION
S107
STATISTICS GATHERING
S109
WINDOW CLASSIFICATION
S110
RECORD WINDOWS
AND IMAGE TYPES
S111
MICRODETECTION
S113
MACRODETECTION
S115
WINDOW GENERATION
S117
LABELING

FIGURE 6

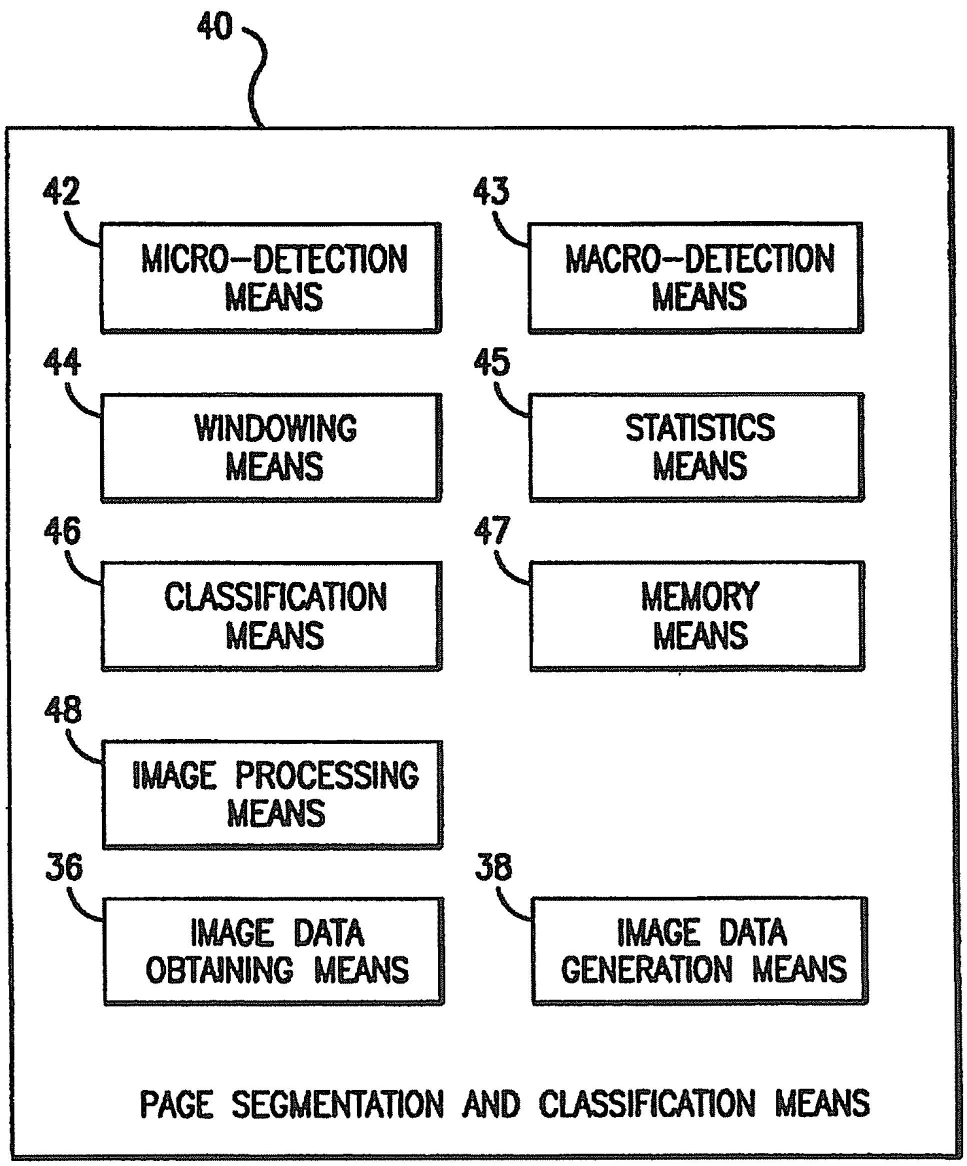

40
42
MICRO-DETECTION MEANS
43
MACRO-DETECTION MEANS
44
WINDOWING MEANS
45
STATISTICS MEANS
46
CLASSIFICATION MEANS
47
MEMORY MEANS
48
IMAGE PROCESSING MEANS
36
IMAGE DATA OBTAINING MEANS
38
IMAGE DATA GENERATION MEANS
PAGE SEGMENTATION AND CLASSIFICATION MEANS

FIGURE 7

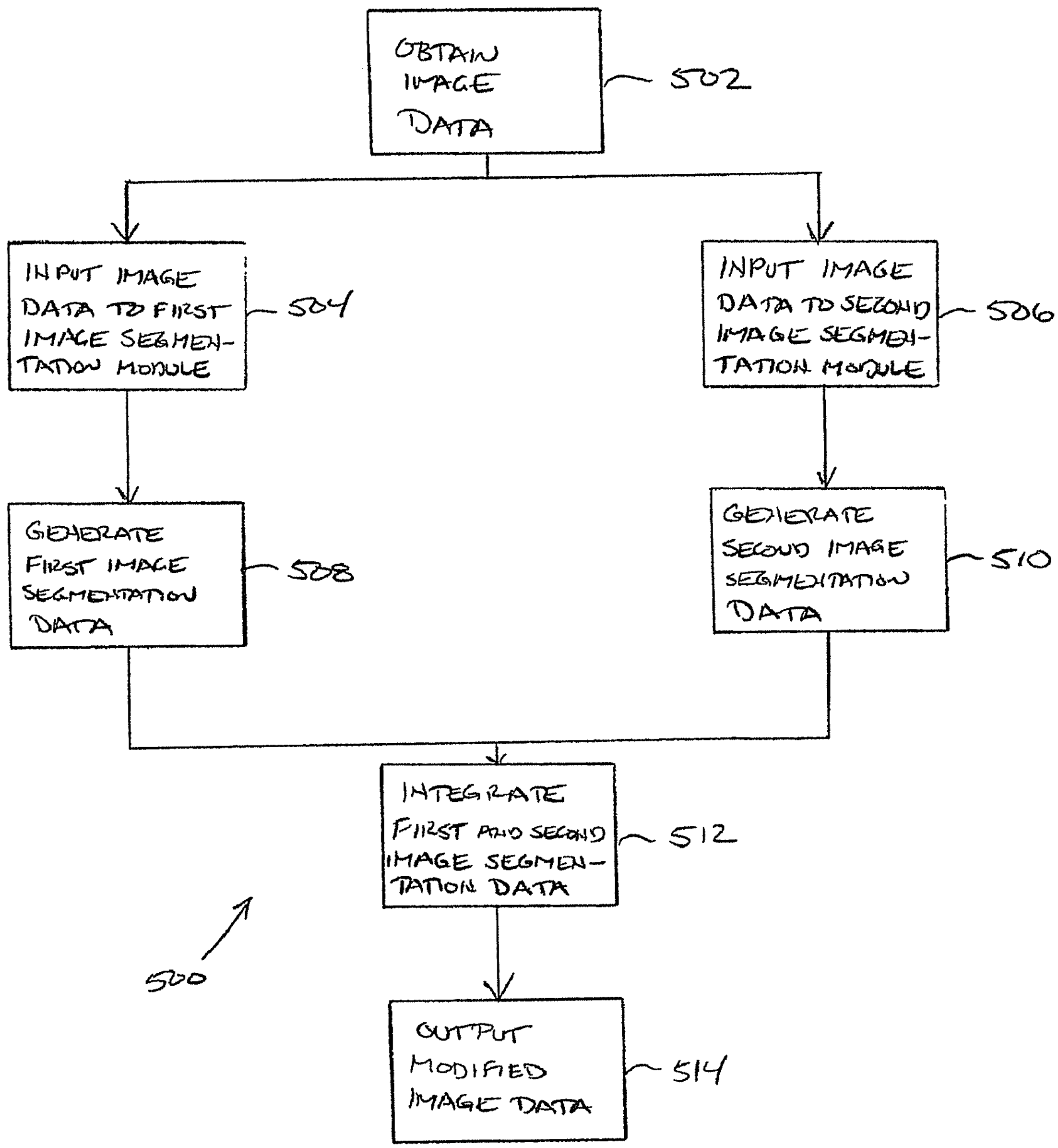

OBTAIN IMAGE DATA
502
INPUT IMAGE DATA TO FIRST IMAGE SEGMENTATION MODULE
504
INPUT IMAGE DATA TO SECOND IMAGE SEGMENTATION MODULE
506
GENERATE FIRST IMAGE SEGMENTATION DATA
508
GENERATE SECOND IMAGE SEGMENTATION DATA
510
INTEGRATE FIRST AND SECOND IMAGE SEGMENTATION DATA
512
500
OUTPUT MODIFIED IMAGE DATA
514

FIGURE 8

METHOD AND APPARATUS FOR SEGMENTING AN IMAGE USING A COMBINATION OF IMAGE SEGMENTATION TECHNIQUES

BACKGROUND OF THE INVENTION

[0001] This invention relates to a method and apparatus for segmenting an image using a combination of image segmentation techniques. More particularly, the invention is directed to an improved image segmentation technique for use in an image processing system that performs at least two distinct image segmentation processes on an image and combines the results to obtain a combined multi-layer representation of the image that can be suitably processed. In a specific example, a block based segmentation technique is performed on an image to generate a MRC (mixed raster content) representation—having foreground, background and selector layers. A pixel based segmentation technique is also performed on the image to generate rendering hints. The MRC representation and the rendering hints are then combined to obtain a four (4) layer representation of the image. The four layer representation is subsequently processed as required by the image processing system, e.g. compressed and stored.

[0002] While the invention is particularly directed to the art of combining image segmentation techniques to obtain a useful result, and will be thus described with specific reference thereto, it will be appreciated that the invention may have usefulness in other fields and applications.

[0003] By way of background, various methods for segmenting images are known. In general, such image segmentation methods are implemented to satisfy a wide variety of image processing needs. For example, when an image is sought to be compressed, it is advantageous to first determine the types of objects (e.g. continuous tone objects, background portions, text, . . . etc.) that are contained in the image. Compression techniques, depending on their precise nature, tend to most effectively compress only certain types of image objects. Thus, images are segmented by object type so that appropriate compression techniques may be applied to each of the respective object types of the image. To illustrate, it is well known in the image processing field that JPEG compression techniques work fairly well on continuous tone pixel maps but do not operate effectively on text. Conversely, the Lempel-Ziv Welch compression techniques do not perform adequately on scanned pixel maps.

[0004] Moreover, the various types of image segmentation methods each possess relative strengths. For example, pixel based image segmentation methods allow for improved image rendering capabilities over other segmentation methods. In this regard, pixel level segmentation methods generate pixel level rendering hints—which are pieces of information that indicate certain characteristics about an image. For example, a rendering hint may indicate the location of an edge within an image. Corresponding windows (whereby all pixels within a window have the same rendering hints) are also utilized. Although the generation of rendering hints and categorization using window identifications are advantageous features of pixel level segmentation from the standpoint of image rendering, a severe disadvantage of such methods is that compression ratios of a pixel based segmented image are not acceptable for many applications.

[0005] Other image segmentation methods that are well known are referred to as block based segmentation methods. That is, the subject image is segmented on a block-by-block basis as opposed to a pixel-by-pixel basis. Block based image segmentation methods attain improved compression ratios over pixel based methods and also are conducive to generating mixed raster content (MRC) data for ease of compression. The disadvantage of block based image segmentation methods, however, is that rendering hints are not effectively generated using these methods. Even if they are generated, use thereof tends to place artifacts on the rendered image.

[0006] As such, a segmentation system that combines the advantages of the above referenced segmentation methods, and others, and utilizes such advantages for improved rendering is desired.

[0007] The present invention contemplates a new and improved image segmentation method and apparatus that resolves the above-referenced difficulties and others.

SUMMARY OF THE INVENTION

[0008] A method and apparatus for segmenting an image using a combination of image segmentation techniques are provided.

[0009] In one aspect of the invention, a method comprises steps of obtaining image data, inputting the image data into a first image segmentation module, generating first segmentation data by the first image segmentation module, the first image segmentation data representing at least one first characteristic of the image data, inputting the image data into a second image segmentation module, generating second image segmentation data by the second image segmentation module, the second image segmentation data representing at least one second characteristic of the image data, and integrating the first image segmentation data with the second image segmentation data to obtain modified image data.

[0010] In another aspect of the invention, inputting the image data to the first image segmentation module and inputting of the image data to the second image segmentation module are accomplished concurrently.

[0011] In another aspect of the invention, the generating of the first image segmentation data comprises generating first characteristic data representing a background layer, a selector layer, and a foreground layer of the image data.

[0012] In another aspect of the invention, the generating of the second image segmentation data comprises generating second characteristic data representing rendering hints.

[0013] In another aspect of the invention, the system for implementing the method according to the present invention is provided.

[0014] In another aspect of the invention, the system comprises means for obtaining image data, means for generating first segmentation data, the first image segmentation data representing at least one first characteristic of the image data, means for generating second image segmentation data, the second image segmentation data representing at least one second characteristic of the image data and means for integrating the first image segmentation data with the second image segmentation data to obtain modified image data.

[0015] In another aspect of the invention, an image rendering system adapted for segmenting an image comprises a

scanner operative to obtain image data, a bitmap generator operative to generate a bitmap corresponding to the image data, a first image segmentation module operative to generate first image segmentation data, the first image segmentation data representing at least one first characteristic of the image data, a second image segmentation module operative to generate second image segmentation data, the second image segmentation data representing at least one second characteristic of the image data, a combining module operative to combine the first image segmentation data with the second image segmentation data to obtain modified image data, a compression module operative to compress the modified image data, a storage module operative to store the compressed image data, a decompression module operative to decompress the stored image data and a print engine operative to render the image based on the decompressed data.

[0016] In another aspect of the invention, the system is included in a xerographic printing environment.

[0017] In another aspect of the invention, the print engine is a xerographic print engine.

[0018] In another aspect of the invention, the first image segmentation data comprises first characteristic data representing a background layer, a selector layer and a foreground layer of the image data.

[0019] In another aspect of the invention, the second image segmentation data comprises second characteristic data representing rendering hints.

[0020] Further scope of the applicability of the present invention will become apparent from the detailed description provided below. It should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art.

DESCRIPTION OF THE DRAWINGS

[0021] The present invention exists in the construction, arrangement, and combination of the various parts of the device, and steps of the method, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in the claims, and illustrated in the accompanying drawings in which:

[0022] **FIG. 1** is a block diagram of an image-rendering device incorporating the present invention;

[0023] **FIG. 2** is a block diagram of an alternative image-rendering device incorporating the present invention;

[0024] **FIG. 3** is a block diagram of an image segmentation module according to the present invention;

[0025] **FIG. 4** is a block diagram illustrating a more specific embodiment of an image segmentation module according to the present invention;

[0026] **FIG. 5** is a flowchart illustrating an exemplary block based segmentation scheme;

[0027] **FIG. 6** is a flowchart illustrating an exemplary pixel based segmentation scheme;

[0028] **FIG. 7** is a block diagram of a system for implementing the scheme of **FIG. 6**; and,

[0029] **FIG. 8** is a flow chart illustrating the method according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] The present invention is directed to an image segmentation method and apparatus that combines the output of a variety of image segmentation modules to obtain an integrated result. This technique allows for the advantageous use of various segmentation methods on the same image. In this way, the same image is segmented a variety of different ways so that, depending on the ultimate use of the output obtained as a result of the implementation of the present invention, advantages of these various methods may be realized.

[0031] Referring now to the drawings wherein the showings are for purposes of illustrating the preferred embodiments of the invention only and not for purposes of limiting same, **FIG. 1** provides a view of an image rendering system into which the present invention is preferably incorporated. As shown, an image rendering system **10** includes a scanner **12** that scans an input document **14**. The data output from the scanner is then input to a pixel map generator **16**, which generates a pixel map that is stored in buffer storage **18**. The data stored in the buffer storage **18** is then input to an image processing unit **20**. The image processing unit **20** includes a segmentation module **22**, a compression module **24**, and a storage module **26**. The image processing unit **20** also includes a processing and control module **28** as well as a decompression module **30**. The image processing unit **20** is connected at its output to a print engine **32** which is operative to render an image in an output document **34**.

[0032] It should be appreciated that the scanner **12**, pixel map generator **16**, and the storage buffer **18** are of conventional design and are operative to generate a scanned, rasterized image and a corresponding pixel map therefore, so that the image may be digitally stored in the buffer. This is accomplished using well-known techniques in the image rendering and image processing fields.

[0033] The image processing unit **20** performs conventional image processing techniques on the image in addition to performing steps of the method according to the present invention. As such, the image processing unit **20** is generally controlled by control module **28**, but may well contain components that are not specifically shown in **FIG. 1**. In addition, the configuration and function of the compression module **24** and decompression module **30** depend on the types of compression and decompression schemes that are used in conjunction with the present invention. Many suitable compression and decompression schemes are well-known to those of skill in this field. Further, the storage device **26** may take any suitable form that can accommodate storage of compressed image data.

[0034] It is also to be understood that the print engine **32** is preferably a xerographic print engine that is well known in the art and can be used in a xerographic printing environment. However, any suitable print engine will suffice.

[0035] Referring now to **FIG. 2**, an alternative environment into which the present invention may be incorporated

is illustrated. More specifically, an image rendering system **50** includes an image processing unit **52** that is operative to receive a pixel map **54**, process the pixel map **54**, and output appropriate data based on the processing to a network **56** or print engine **58**.

[0036] It is to be appreciated that the pixel map **54** may be generated within a network and digitally stored prior to its input to the image processing unit **52**. Other various known ways of generating a pixel map or a bit map may also be used. The image processing unit **52** takes the form similar to the image processing unit **20** in that it includes the segmentation module **60**, the processing and control module **62**, a compression module **64**, a storage module **66** and a decompression module **68**. Of course, if the compressed image is transmitted over a network **56**, the decompression of that image will preferably occur at the receiver. For example, decompression may occur within a fax machine, another processing terminal, . . . etc. The network **56** may be a local area network, a wide area network, or the Internet. Like the print engine **32** of **FIG. 1**, it is also to be understood that the print engine **58** is preferably a xerographic print engine that is well known in the art and can be used in a xerographic printing environment. However, any suitable print engine will suffice.

[0037] As noted above, the present invention may be applied in both of the environments described in connection with **FIGS. 1 and 2**, as well as others. In either case shown, referring now to **FIG. 3**, the segmentation module **22** (or **60**) includes a plurality of distinct segmentation modules **100**. Each such segmentation module **100** is operative to generate image segmentation data representing various characteristics of the image data. Of course, it is to be appreciated that segmentation becomes more robust with the addition of further segmentation modules.

[0038] This image segmentation data is then combined, or integrated, at module **102** and the overall segmentation result is output. Preferably, the segmentation modules **100** are each distinct from one another to the extent that they generate image segmentation data representing different characteristics of the image data. The combining module **102** then preferably generates data representing all of the characteristics for which segmentation was accomplished by integrating the results of each of the segmentation modules. This data can then be used advantageously for a variety of desired purposes within any image rendering or networked computer system, as illustratively shown in **FIGS. 1 and 2**.

[0039] With reference to **FIG. 4**, a more specific embodiment according to the present invention is illustrated. It is to be appreciated that the segmentation module illustrated in **FIG. 4** is but one preferred embodiment of the present invention. It will be further appreciated that the details of implementation may be modified to suit the needs of a particular application. For example, different segmentation techniques than are shown could be used.

[0040] As shown, however, the image segmentation module **22** (or **60**) is provided with a block based (or, more generally, object based) image segmentation module **200** and a pixel based image segmentation module **202**. The input image is provided to each of these segmentation modules.

[0041] The output of the block based segmentation module **200** preferably is a three-layered mixed raster content file. Preferably, these layers represent background, foreground, and selector fields. Likewise, the pixel based image segmentation module **202** has an output. This output includes rendering hints. The outputs of each of the image segmentation modules **200** and **202** are combined at combining module **204** to produce a four layered mixed raster content (MRC) data file. Again, this modified (e.g. optimized) image data is utilized in manners accommodated by the particular system into which the invention is incorporated. Preferably, the data in the form using MRC representation is in a device independent color space such as Lab. As to the environment shown in **FIGS. 1 and 2**, the data is compressed, stored, transmitted and/or used in rendering.

[0042] With respect to the operation of the block based image segmentation module **200**, any blocked or object based technique that outputs a layered MRC representation will suffice. However, a preferred exemplary segmentation technique that produces a three layered output is illustrated in U.S. Pat. No. 5,778,092 to MacLeod et al. (issued Jul. 7, 1998) entitled "Method and Apparatus For Compressing Color or Gray Scale Documents," commonly assigned and incorporated herein by reference.

[0043] As disclosed therein, the pixel map representing a color or gray-scale document is decomposed into a three-plane page format. The document format is comprised of a "foreground" plane, a "background" plane, and a "selector" plane. The "foreground" and "background" planes are stored at the same bit depth and number of colors as the original raw pixel map, but usually at reduced resolution. The "selector" plane is created and stored as a 1 bit per pixel bitmap.

[0044] Each of the planes is comprised of a corresponding map that may be ultimately compressed using a compression method suitable for the data contained in the plane, as referenced above. For example, the foreground and background planes may be compressed and stored using JPEG, while the selector plane may be compressed and stored using a symbol-based compression format. It would be apparent to one of skill in the art to compress and store the planes using other formats that are suitable for the intended use of the color document.

[0045] The "background" plane contains two things. First, it contains the color of the "background" of the page, including the color of tints, washes, etc. Second, it contains the continuous-tone pictures that are found on the page. The "foreground" or "ink" plane contains the "ink colors" of foreground items such as text.

[0046] The "selector" plane is stored at a higher resolution (e.g. 600 spots/inch for a 300 spots/inch original document). The purpose of the selector plane is to describe, for each pixel in the selector plane, whether to use the pixel value found in the background plane or the foreground plane. A "white" pixel in the selector plane (i.e. a logical zero value) means the pixel value should be taken from the corresponding pixel from the background plane. A "black" pixel in the selector plane (i.e. a logical one value) means that the pixel value should be taken from the corresponding pixel from the foreground plane. Preferably, the selector, foreground and background planes are brought to the same resolution before the selector is used to generate the single plane image.

[0047] Referring to **FIG. 5**, a pixel map representation of the document is obtained (step **302**). This may be through

scanning an original of the document, or by retrieving a stored pixel map representation of the document, depending on whether the system of **FIG. 1** or **FIG. 2** is implemented, for example. The pixel map representation is then analyzed to generate the information for the three planes. The first step of the analysis is to create a thresholded bitmap from the original pixel map (step **304**). Generally, the thresholding step creates a new bitmap containing binary values is formed based on an adaptively determined threshold value. The thresholded bitmap is desirable since it eliminates undesirable artifacts. Using the threshold bitmap, a reduced resolution foreground map containing color (or gray scale) information of foreground items, such a text is computed (step **306**).

[0048] The reduced resolution background map is then computed (step **308**). In this step, the "image" or non-text portions are identified by an image segmentation process. This information is used to create the reduced resolution background map which contains background color information as well as continuous tone image information.

[0049] Next, the selector plane is computed (step **310**). The selector plane is a bitmap computed using a suitable thresholding technique on the original pixel map. Of course, optionally, the layers are then compressed if required by the system (step **312**).

[0050] With respect to the pixel based image segmentation module **202**, any of a variety of pixel based schemes the are well known in the field may be utilized. Preferably, however, the pixel based scheme described in U.S. Pat. No. 5,850,474 to Fan et al. (issued Dec. 15, 1998) entitled "Apparatus and Method For Segmenting and Classifying Image Data" and U.S. Pat. No. 5,293,430 to Shiau et al. (issued Mar. 8, 1994) entitled "Automatic Image Segmentation Using Local Area Maximum and Minimum Image Signals", both of which are commonly assigned and incorporated herein by reference, is used.

[0051] In the disclosed method, as recited in U.S. Pat. No. 5,850,474, a block diagram of a two pass segmentation and classification method embodying the invention is shown in **FIG. 6**. The method segments a page of image data into windows, classifies the image data within each window as a particular image type and records information regarding the window and image type of each pixel. Once the image type for each window is known, further processing of the image data can be efficiently performed.

[0052] The image data comprises multiple scanlines of pixel image data, each scanline typically including intensity information for each pixel within the scanline. Typical image types include graphics, text, low-frequency halftone, high-frequency halftone, contone, etc.

[0053] During a first step **S101**, micro-detection is carried out. During micro-detection, multiple scanlines of image data are buffered into memory. Each pixel is examined and a preliminary determination is made as to the image type of the pixel. In addition, the intensity of each pixel is compared to the intensity of its surrounding neighboring pixels. A judgment is made as to whether the intensity of the pixel under examination is significantly different than the intensity of the surrounding pixels. When a pixel has a significantly different intensity than it neighboring pixels, the pixel is classified as an edge pixel.

[0054] During a second step **S103**, a macro-detection is performed. During the macro-detection step, the results of the micro-detection step are used to identify those pixels within each scanline that are edges and those pixels that belong to image runs. The image type of each image run is then determined based on the micro-detection results. The image type of an image run may also be based on the image type and a confidence factor of an adjacent image run of a previous scanline. Also, if an image run of a previous scanline was impossible to classify as a standard image type, but information generated during examination of the present scanline makes it possible to determine the image type of the image run of the previous scanline, that determination is made and the image type of the image run of the previous scanline is recorded.

[0055] In the next step **S105**, the image runs of adjacent scanlines are combined to form windows. A window is thus a contiguous area, of an arbitrary shape, in an image where all pixels are of the same class.

[0056] In the next step **S107**, statistics are gathered and calculated for each of the windows. The statistics are based on the intensity and macro-detection results for each of the pixels within a window.

[0057] In the next step **S109**, the statistics are examined in an attempt to classify each window. Windows that appear to contain primarily a single type of image data are classified according to their dominant image types. Windows that contain more than one type of image are classified as "mixed".

[0058] At the end of the first pass, in step **S110**, the beginning point and the image type of each of the windows is recorded.

[0059] During the second pass, in steps **S111**, **S113** and **S115**, the micro-detection, macro-detection and window generation steps, respectively, are repeated. In the next step **S117**, labeling of the pixels occurs. During the labeling step, information about the image type and the window of each pixel is recorded. If a pixel is within a window that was classified as "mixed" during the first pass, the micro-detection, macro-detection and windowing steps performed during the second pass are used to assign an image type to the pixel. At the end of the labeling step, each pixel is labeled as a particular image type.

[0060] Once each portion of the image data has been classified according to standard image types, further processing of the image data can be efficiently performed. Because the micro-detection and macro-detection results from the first pass are not recorded for each pixel of the image, the memory requirements for a device embodying the invention are minimized. This helps to minimize the cost of such an apparatus.

[0061] A block diagram of a page segmentation and classification apparatus capable of performing the two pass method is shown in **FIG. 7**. The page segmentation and classification means **40** includes micro-detection means **42** for performing the micro-detection step, macro-detection means **43** for performing the macro-detection step and windowing means **44** for grouping the image runs of the scanlines together to form windows. The apparatus also includes statistics means **45** for gathering and calculating statistics regarding the pixels within each window and

classification means **46** for classifying each of the windows as a particular image type based on the gathered statistics.

[0062] Memory means **47** are provided for recording the beginning points and image types of each of the windows and the beginning points and image types of any initially unknown image runs that were subsequently classified during the first pass. The memory means **47** may also be used to store the window and image type of each pixel at the end of the second pass. Typically, however, the image data is used immediately to process, transmit and/or print the image, and the image data is discarded.

[0063] The page segmentation and classification means **40** may also include image processing means **48** for processing the image data after each of the pixels has been labeled with an image type and as belonging to a particular window.

[0064] A page segmentation and classification apparatus embodying the invention might include a typical computer processor and software designed to accomplish each of the steps of the two pass method. The apparatus might also include image data obtaining means **36** for obtaining an image to be processed by the two pass method. The image data obtaining means **36** could include a scanner or a device for reading a stored image from a memory. The device might also include image data generation means **38** for generating image data to be segmented and classified by the two pass method. The image data generation means could include a software program for generating an image or a word processing program that generates a page of text or a page of mixed text and images.

[0065] It is to be appreciated that the outputs of the module **200** and module **202** are combined—as those skilled in the art will appreciate—in combining module **204** to output data that takes the form of four layered segmentation data. In this regard, the data may be stored in four separate files, one file for each layer, or a single file having four identifiable portions. Once the data is in this format, it may be used advantageously and selectively by the system for a variety of desired purposes that can be implemented in the system.

[0066] The output data is in modified form, as compared to the original image data. In certain circumstances, the modified data is of optimal form for particular applications. Preferably, the output data includes a background layer, a foreground layer, and a selector layer, obtained through the implementation of the block or object based method described above, and a rendering hints layer obtained through the implementation of the pixel based method described above. As to the pixel-based data, it preferably includes information (e.g. statistics) on each pixel type as well as information on the window corresponding to each pixel.

[0067] As an alternative, windowed objects identified by the pixel based segmentation process may be placed in separate partial planes so they can be readily extracted for editing or other suitable purposes.

[0068] Referring to **FIG. 8**, a method according to the present invention is illustrated. The method **500** is initiated by obtaining image data (step **502**). Initially, obtaining the image data may be accomplished using the scanning techniques discussed above (e.g. via scanner **12**) as well as other well-known techniques (e.g. in the system of **FIG. 2**) in combination with other image processing and control procedures, such techniques and procedures typically being a function of the implementation. This image data is then input to a first segmentation module (step **504**). Preferably, the first image segmentation module is a block or object based segmentation module **200** that is capable of generating MRC data representations. The image data is then input to a second image segmentation module (step **506**). The second image segmentation module preferably takes the form of a pixel-based image segmentation module **202** that is operative to generate rendering hints that are useful in rendering the original image. In the preferred embodiment, the image data is input to both the first and second image segmentation modules concurrently or simultaneously.

[0069] The first image segmentation module then generates first segmentation data (step **508**). The first image segmentation data preferably is MRC data that representatively includes layers of background data, foreground data, and selector data. Likewise, the second image segmentation module generates second segmentation data (step **510**). As alluded to above, the second image segmentation data comprises rendering hints. These hints may take a variety of forms, but in the preferred embodiment, the rendering hints include statistics on the pixels and information on the corresponding windows—all such information tending to identify characteristics about the pixel such as whether such pixels are edge pixels or half-tone pixels. Preferably, these two tasks of generating data are accomplished concurrently. This could occur whether or not the image data is concurrently input to the respective segmentation modules.

[0070] Once steps **508** and **510** are complete, the first segmentation data is integrated with the second segmentation data (step **512**). The integration of these two types of data is essentially a summing of the data forms. The resultant output data thus includes four total layers, three generated by the first segmentation module and one generated by the second segmentation module. That is, it includes a background layer, a foreground layer, and a selector layer—obtained through the implementation of the block or object based method described above—and a rendering hints layer representing the image data, or rendering hints—obtained through the implementation of the pixel based method described above. This summation of data may be accomplished using any suitable technique. Of course, the manner of integration may well be a function of the manner in which the output data is maintained and stored. In this regard, the four layers may be stored in separate files or in separate buffers. Likewise, the data may be stored in a single file or on a single storage medium having suitable demarcation capabilities.

[0071] It is important to note that some common cases can be specified in advance as "defaults", thus the image representation can be simplified. For example, in common documents the text is black. We can specify the default foreground to be black, and if the foreground layer is missing, it is understood to be black. In such cases, the foreground layer does not need to be generated and stored, thus simplifying the process and reduce storage space. Likewise, a common type of image is text of different colors on a white background. We can specify the default background to be white, and if the background layer is missing, it is understood to be white. In such cases, the apparent number of layers of the image representation can be reduced.

[0072] Last, the modified image data obtained as a result of the integration is output (step 514). Typically, image data is segmented most advantageously for the purposes of conducting data compression. Once compressed, the data is stored, transmitted and/or used for image rendering. In the case where the data is transmitted, the modified output data must be decompressed at the receiver or destination thereof. In the case of image rendering, the data is preferably decompressed prior to being provided to the print engine.

[0073] It should be appreciated that the present invention may be implemented using a variety of suitable hardware and software techniques, many of which are referenced above. However, any such suitable implementation techniques should be apparent to those skilled in the art upon a reading of the present description.

[0074] The above description merely provides a disclosure of particular embodiments of the invention and is not intended for the purposes of limiting the same thereto. As such, the invention is not limited to only the above-described embodiments. Rather, it is recognized that one skilled in the art could conceive alternative embodiments that fall within the scope of the invention.

Having thus described the invention, we hereby claim:

1. A method for segmenting an image, the image comprising pixels and being represented by image data, the method comprising steps of:

obtaining image data;

inputting the image data into a first image segmentation module;

generating first segmentation data by the first image segmentation module, the first image segmentation data representing at least one first characteristic of the image data;

inputting the image data into a second image segmentation module;

generating second image segmentation data by the second image segmentation module, the second image segmentation data representing at least one second characteristic of the image data; and,

integrating the first image segmentation data with the second image segmentation data to obtain modified image data.

2. The method as set forth in claim 1 wherein the inputting of the image data to the first image segmentation module and the inputting of the image data to the second image segmentation module are accomplished concurrently.

3. The method as set forth in claim 1 wherein the generating of the first image segmentation data comprises generating first characteristic data representing a background layer, a selector layer and a foreground layer of the image data.

4. The method as set forth in claim 1 wherein the generating of the second image segmentation data comprises generating second characteristic data representing rendering hints.

5. The method as set forth in claim 1 wherein the integrating of the first and second image segmentation data comprises generating the modified image data such that it comprises a background layer, a selector layer, and a foreground layer of the image data and a layer of information representing rendering hint for the image data.

6. A system for segmenting an image, the image comprising pixels and being represented by image data, the system comprising:

means for obtaining image data;

means for generating first segmentation data, the first image segmentation data representing at least one first characteristic of the image data;

means for generating second image segmentation data, the second image segmentation data representing at least one second characteristic of the image data; and,

means for integrating the first image segmentation data with the second image segmentation data to obtain modified image data.

7. The system as set forth in claim 6 further comprising means for inputting the image data to the first image segmentation module and inputting the image data to the second image segmentation module concurrently.

8. The system as set forth in claim 6 wherein the first image segmentation data comprises first characteristic data representing a background layer, a selector layer and a foreground layer of the image data.

9. The system as set forth in claim 6 wherein the second image segmentation data comprises second characteristic data representing rendering hints.

10. The system as set forth in claim 6 wherein the modified image data comprises a background layer, a selector layer, and a foreground layer of the image data and a layer of information representing rendering hint for the image data.

11. The system as set forth in claim 6 wherein the means for generating the first segmentation data comprises a first segmentation module.

12. The system as set forth in claim 6 wherein the means for generating the second image segmentation data comprises a second image segmentation module.

13. The system as set forth in claim 11 wherein the first segmentation module comprises a block based image segmentation module.

14. The system as set forth in claim 11 wherein the first segmentation module comprises an object based image segmentation module.

15. The system as set forth in claim 12 wherein the second image segmentation module comprises a pixel based image segmentation module.

16. An image rendering system adapted for segmenting an image, the image comprising pixels and being represented by image data, the system comprising:

a scanner operative to obtain image data;

a bitmap generator operative to generate a bitmap corresponding to the image data;

a first image segmentation module operative to generate first image segmentation data, the first image segmentation data representing at least one first characteristic of the image data;

a second image segmentation module operative to generate second image segmentation data, the second image segmentation data representing at least one second characteristic of the image data;

a combining module operative to combine the first image segmentation data with the second image segmentation data to obtain modified image data;

a compression module operative to compress the modified image data;

a storage module operative to store the compressed image data;

a decompression module operative to decompress the stored image data; and,

a print engine operative to render the image based on the decompressed data.

17. The system as set forth in claim 16 wherein the system is included in a xerographic printing environment.

18. The system as set forth in claim 16 wherein the print engine is a xerographic print engine.

19. The system as set forth in claim 16 wherein the first image segmentation data comprises first characteristic data representing a background layer, a selector layer and a foreground layer of the image data.

20. The system as set forth in claim 16 wherein the second image segmentation data comprises second characteristic data representing rendering hints.

21. The system as set forth in claim 16 wherein the first and second segmentation data comprises layers whereby an absence of a selected layer establishes a default position for a characteristic represented by the selected layer.

22. The system as set forth in claim 16 further comprising a third image segmentation module operative to generate third image segmentation data.

23. The system as set forth in claim 22 wherein the combining module is operative to combine the third image segmentation data with the first and second image segmentation data.

* * * * *

XIV. APPENDIX E - RELATED CASES APPENDIX

NONE

a combining module operative to combine the first image segmentation data with the second image segmentation data to obtain modified image data;

a compression module operative to compress the modified image data;

a storage module operative to store the compressed image data;

a decompression module operative to decompress the stored image data; and,

a print engine operative to render the image based on the decompressed data.

17. The system as set forth in claim 16 wherein the system is included in a xerographic printing environment.

18. The system as set forth in claim 16 wherein the print engine is a xerographic print engine.

19. The system as set forth in claim 16 wherein the first image segmentation data comprises first characteristic data representing a background layer, a selector layer and a foreground layer of the image data.

20. The system as set forth in claim 16 wherein the second image segmentation data comprises second characteristic data representing rendering hints.

21. The system as set forth in claim 16 wherein the first and second segmentation data comprises layers whereby an absence of a selected layer establishes a default position for a characteristic represented by the selected layer.

22. The system as set forth in claim 16 further comprising a third image segmentation module operative to generate third image segmentation data.

23. The system as set forth in claim 22 wherein the combining module is operative to combine the third image segmentation data with the first and second image segmentation data.

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XIV. APPENDIX E - RELATED CASES APPENDIX

NONE